

# ARMOUR IN PROFILE

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## ARMoured FIGHTING VEHICLES of the United States Army, 1945-2018



**M.P Robinson, David Grummitt & Leif Robinson**

 Guideline Publications



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An M60A1 Main Battle Tank of the 1<sup>st</sup> Tracked Vehicle Battalion of the 3<sup>rd</sup> Marine Division, United States Marine Corps, takes part in a live-fire exercise during Exercise Bear Hunt held in South Korea in 1984. (US Navy/Cpl. S.T. Quade)



# INTRODUCTION

**David Grummitt gives a brief history of the United States armoured forces to 1945.**

**T**he current United States Armor Force, the branch of the US Army that has oversight of the armoured fighting vehicles of both the armoured and infantry units and trains the tank commanders of the US Army and United States Marine Corps (USMC), can trace its origins to World War I. The United States entered the Great War in 1917 and by the end of the year the United States Tank Corps had been established on the Western Front, comprising of French Renault light tanks and British Mk. V and Mk. VI medium tanks. The tanks made their combat debut in autumn of 1918 and were employed in the Meuse-Argonne offensive, the final Allied push of the War and still the largest offensive (involving over 1.2million American soldiers) in US military history.

In February 1918 the Tank Service of the National Army was established to train tank crews and a training facility was established on site of the Civil War battlefield of Gettysburg. The following month the Tank Service was renamed the Tank Corps of the National Army. Further camps were established throughout the year and by Armistice Day the Tank Corps had 483 officers and 7,700 men in its service. Production also began of the M1917, a licence-built copy of the French Renault FT tank, but only 950 of the projected 4,400 tanks were built before hostilities ended and this first American-built tank never saw actual combat. In 1919 it was proposed that the National Army and its constituent tank forces be disbanded and the following year the remaining two heavy and four light tank battalions were absorbed into the infantry branch. An indigenous tank design, the two-man Ford 3-ton M1918, was also abandoned with the end of the War.

In the 1920s and 30s American armour suffered

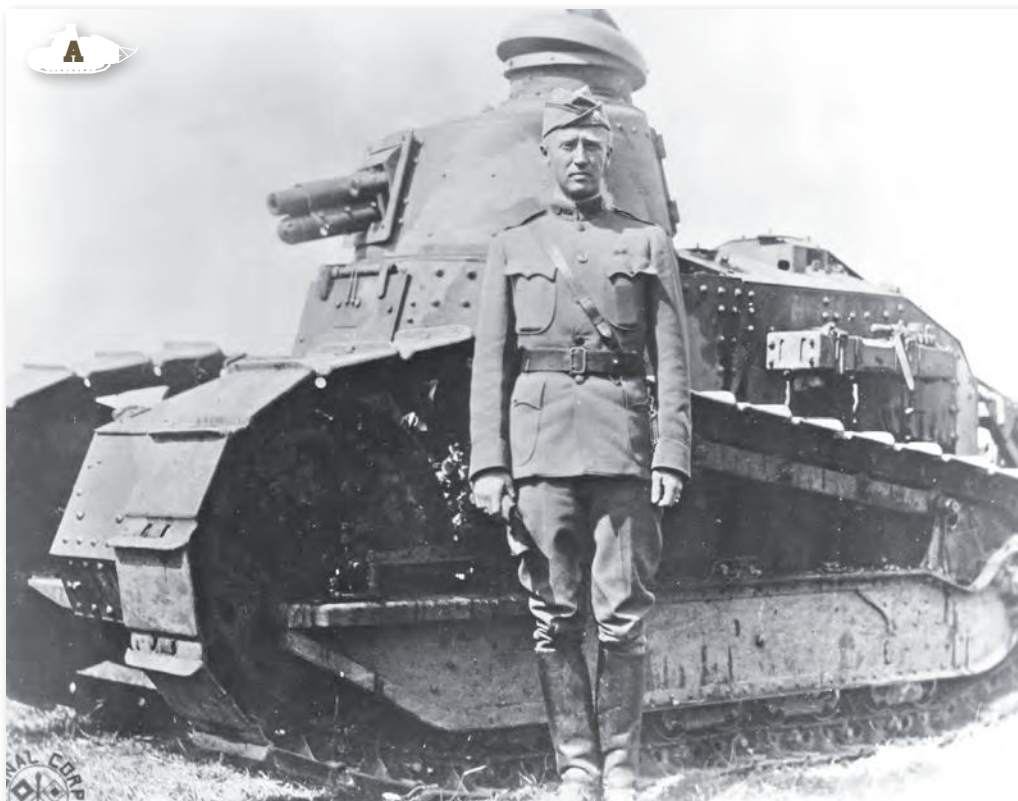
from similar problems to those that plagued the early years of the British Royal Armoured Corps: tanks were seen as subordinate to the traditional arms of infantry and cavalry and there were no efforts to establish an independent armoured branch or design effective combined-arms tank tactics. In 1928 there was an initiative to develop a new tank arm, but this was thwarted by insufficient funding a year later. One positive development, however, was the work of the American tank designer, J. Walter Christie. Although his

innovative suspension design was spurned by the American army, it was adopted elsewhere and went on to inspire the suspension system of the Soviet T-34, the most influential tank design of World War II.

During the 1930s the United States had no real success in developing an effective medium tank and little more in designing a light tank. The M1 Combat Car and M2 Light Tank saw limited service, with the latter even serving with the USMC in Guadalcanal in 1942, while the M2 medium tank entered production in 1939

with only 112 units produced. In response to the obvious success and importance of tanks in the opening campaigns of the War, however, the Armor Branch of the US Army was created on 10 July 1940.

During World War II the armoured forces of the US Army and USMC emerged as vital factors in the eventual Allied victory. In late 1941 the first M3 Lee medium tanks entered service. It was an interim solution, combining the obsolete turret-mounted 37mm of the M2 with a hull sponson-mounted 75mm gun.



**A** A young George S. Patton, one of the most charismatic and influential US tank generals of World War II, stands alongside a Renault FT light tank in 1918. (US Army)

**B** The M2A3, a light tank introduced in 1938. This was a modification of the twin-turreted M2A2 with a longer wheelbase and more widely spaced bogies to improve the ride. (US Army)





Some 6,200 were produced up to 1942 and they saw action in North Africa, on the Eastern Front and in the Pacific with the Americans and their allies. The M3 was superseded in production by the M4 Sherman, one of the most iconic tanks of all time, in February 1942. The Sherman tank, of which some 49,200 were built between 1942 and the end of the War, was one of the most important weapons of World War II, serving in all theatres of war. It also served as a potent symbol of American military and industrial power. While it may have been inferior to the German Panzer IV, Panther and Tiger tanks, the sheer number of Sherman tanks in the American and Allied armies prevailed.

As well as the M3 Lee and M4 Sherman tanks, the United States developed a range of other tanks that would shape US armoured doctrine in subsequent years. The successors to the M2 light tank were the M3 and M5. Both were armed with the 37mm gun, while the latter had a redesigned hull. In the Pacific the M3/M5 was often used in tank-to-tank encounters against the generally light Japanese tanks, but in North Africa, Italy and North-West Europe, it was used in the traditional cavalry roles of reconnaissance and scouting. The M5 was superseded in 1944 by the M24 Chaffee light tank. Fast, agile and armed with a 75mm gun, this was one of the most effective American tank designs of the War and saw service in the Korean War and beyond with other nations. The experience of the M4 Sherman against the heavier German

tanks led to the development of the M26 Pershing. Armed with a 90mm gun it was the only US tank that could engage the German Pz.Kpfw V Panther or Pz.Kpfw VI Tiger on anything like equal terms. Eventually 2,222 were produced, but only twenty were delivered and saw action in Europe before the end of World War II.

In this collection of articles, we will examine the history and deployment of US armour in the years from 1945. From the battlefields of Korea, through the jungles of Vietnam and the deserts of Iraq, we'll see how the US Armor Force has developed into the preeminent tank force in the world today. The combination of the Abrams Main Battle Tank and the Bradley Fighting Vehicle, supported by the Paladin self-propelled howitzer, ensures that the Armoured Brigade Combat Teams of today's US Army continue the proud traditions of their forebears and meet the challenges of war and peace for decades to come.

**C** A colourful M4A3E8 Sherman prepares for the Han River offensive during the Korean War. *(US Army)*

**D** An M48A3 Patton, laden with infantry, searches for Viet Cong in the Vietnamese jungle. *(US Army)*

**E** M60A1s of 2nd Marine Division, USMC, on exercise in South Korea in 1982. *(US Navy/Sgt. Aaron F. Potter)*

**F** The M2/M3 Bradley Fighting Vehicle is an integral part of the United States armoured forces of today. Serving both as an infantry fighting vehicle and for cavalry reconnaissance and scouting, its ability to fight alongside the Abrams Main Battle Tank is central to US warfighting doctrine. *(US Army/Spc. Ryan Tatum).*





# ARMOUR IN PROFILE



M.P Robinson examines the evolution of the United States Medium Tank from 1945 to 1960.



## FROM SHERMAN TO PATTON

Of the various tanks produced during World War II the American M4 Medium 'Sherman' series was notable for its basic quality and as a template for future production programs. The M4A1 and M4A3 were both produced in updated 76mm gunned versions that served in the US Army until the middle of the 1950s. In 1945 the M26 was intended at first to be the army's heavy tank and subsequently as the successor

medium tank to the M4 series. It introduced the basic features common to the next generation of American medium tanks. These included the adoption of the torsion bar suspension, the low profile hull and the M3 90mm gun. The turret was a substantial steel casting and the hull incorporated cast and welded sections. The extensive use of cast armour remained consistent in American medium tank design for the next 20 years. By the end of the war over

300 T26s and M26s had been sent to Northwest Europe and over 2,200 were built by 1946. In Germany, the M3 90mm gun proved to be an effective weapon against the Wehrmacht's Panther and Tiger I tanks at normal combat ranges. The M3 gun went on to be developed further in the successor M47 and M48 designs. The first postwar medium tank upgrade was a stop-gap effort to re-engine the M26 pending the development of better types, which resulted in the refurbishment program

that produced the M46 Patton. The Pershing and Patton's real baptism of fire came in Korea, where the type's 90mm gun proved capable of penetrating the T-34/85 frontally at all combat ranges. As a result, there was a scramble to get enough M26 and M46s rounded up, overhauled and shipped to South Korea for the Army and for the Marines. The hilly Korean terrain of proved to be hard going for the underpowered M26, which was also criticised for its high fuel consumption. The reserve of power that was

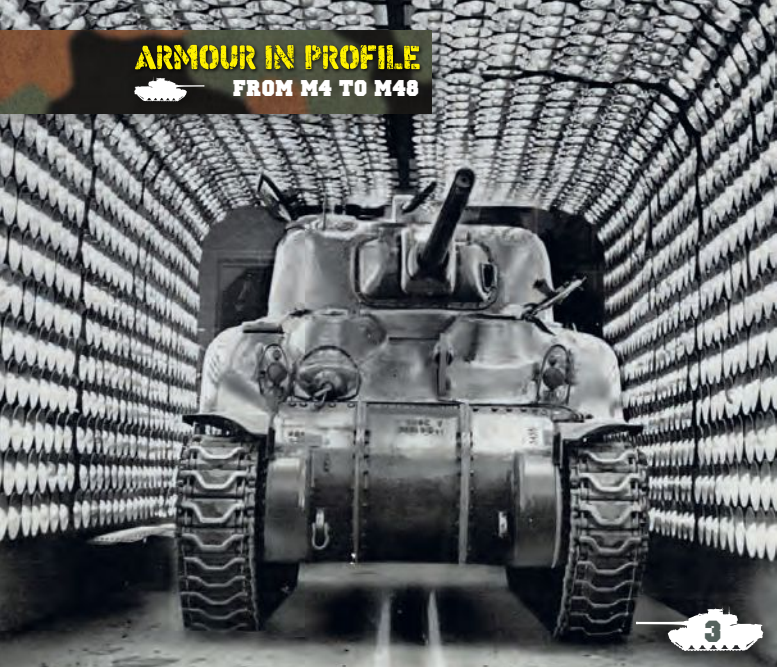


**1** In early 1948 the problem of the Pershing's poor power to weight ratio was addressed by replacing the original Ford GAF engine. The new Continental AV1790-3 engine and Allison CD-850 cross-drive transmission offered 740 HP. The Allison transmission functioned as a steering, braking and transmission unit. The modified design was re-designated M46 and was nicknamed Patton. The M46 upgrade was intended to be a stopgap measure to improve the M26's mobility

until such time that it could be replaced by the T42 Medium Tank. When the M46's powertrain was improved with a modified cooling system and transmission improvements, it received the designation M46A1. In total, 1,160 M26 and M26A1s were transformed into M46s and M46A1s from November 1949. This Marine Corps M46 was photographed operating in support of Turkish forces in Korea in 1953. (US NARA)

**2** An M47 tank at the Third Cavalry Museum, Fort Hood, Texas.





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available to the upgraded M46 made it much better suited to hill climbing. The older M4A3E8s also did sterling service in Korea, but this proved to be the Sherman's last major war in American service. The Korean War proved a powerful impetus to give American tank design programs the priority lacking since 1945. Many risks were accepted to get the new M47 medium tank into production quickly after the Cold War arms race started. The M47 design was a stop-gap that combined the T42 medium tank's turret and the existing M46 pattern medium tank hull. The resulting vehicle was speedily ordered and adopted in the United States Army, but it was destined to be retired almost as quickly as sufficient M48s could be built to replace it. The M48, rushed into production from the T48 design, had many developmental problems of its own. None of the flaws in the original models of these tanks took away from the fact that US postwar medium tank design practice was fundamentally sound. The M46, M47 and M48 were all effective designs that did well in combat and the early pattern M47s and M48s were eventually improved to a satisfactory standard through



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rebuild programs and in the case of the M48, with the adoption of improvements introduced in the M60 series. The M60 replaced many of the M48s deployed in US armoured divisions in Western Europe after the early 1960s, but the M48A3 served admirably in Vietnam. The M48 soon proved capable of mounting the L7 or M68 105mm gun and up-gunned Israeli M48s proved themselves in combat in 1967 and 1973 against the most modern Soviet medium tanks. The United States eventually rebuilt over 2,000 M48A3s to mount the M68 105mm gun as M48A5s.

**3** Over 49,000 M4 series tanks were produced. It was built on at least 10 major production lines with 4 main powertrain types, cast and welded hulls, and with 3 factory standard main armament types. The Sherman's wartime record was not flawless but the design proved to be tremendously adaptable and durable. This is a wartime photograph of a freshly painted M4A1 Sherman passing through drying lamps. The original cast-hulled M4A1 was built by Lima Locomotive Works, Pressed Steel Car Company and Pacific Car and Foundry Company, all companies that had extensive experience building locomotives and rolling stock in the years before World War 2. (*US Army*)

**4** Between 1940 and 1945 the United States transformed itself into an industrial and military superpower. When the United States entered the war in December 1941 much of its industrial might was already in the process of being harnessed to meet the needs of the American army. The M3 Medium was the first American Medium Tank to see combat. While it was quickly eclipsed by the Sherman, the M3 series set the template for manufacture methods and practices that evolved through the war and over the following decades. (*US Library of Congress Photo*)

**5** After the end of the war the United States Army retained thousands of brand new late production Shermans in service, largely M4A1 variants with the 76mm turret and M4A3s equipped with the 76mm or 105mm turret. A huge number of Shermans produced during the war were gifted to America's allies or refurbished for issue under favourable military aid plan terms. These served in the armies of a dozen different countries for many years, as well as in the United States (as a training vehicle and as a standard combat weapon right up until 1954). Even though it was inferior in terms of armour and firepower to the M26, the M4A3E8 held the record for the greatest number of enemy AFVs destroyed in the Korean war. (*Ed Stuczko*)

**6** American wartime tank production was an exercise in continuous improvement. This process literally transformed the M4 series from simple into sophisticated weapons. The M4A1 was the first of the Shermans to appear with the new 76mm gun in 1944. After the war many were rebuilt with the Horizontal Volute Suspension System and these were employed by the National Guard and by many of America's allies under to Military Aid Plan. In the period after the Japanese surrender the production of tanks ceased abruptly and it





did not start again on a large scale until 1950. When medium tank production resumed, production was undertaken in a smaller number of arsenals, but in substantial numbers. **(US Army)**

**7** The M4A3E8 was also an important part of the United States Army's training establishment. This vehicle, named Aggie, was photographed being sprayed down after training in the United States in the 1950s. **(US Army)**

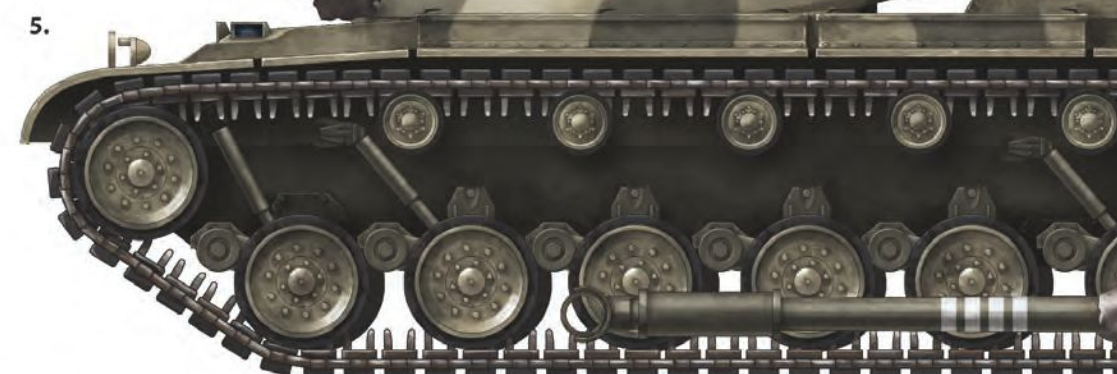
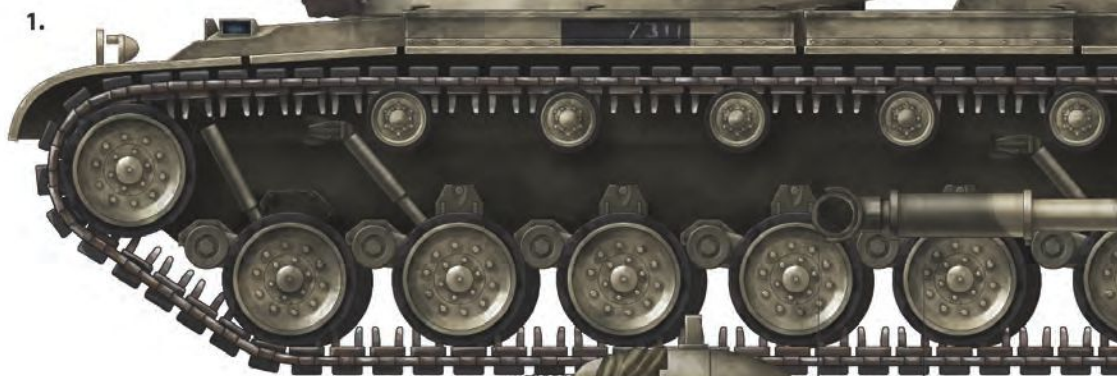
**8** A heavily weathered M26 Pershing on the 1st Marine Division in Korea. In 1950 the Marines had their M4A3 105mm tank replaced with Pershings. **(NARA)**

**9** Pershing: the M26 was the designation assigned to the T26 heavy tank in early 1945, some weeks after it was introduced into service. The M26 was a fine combat vehicle that might have been available earlier than was the case, largely due to complacency, the view in the US Army that the Tank Destroyer Force (and not the Armored Force) should receive such heavily armed vehicles, and because the US Army had no real doctrine for the use of a heavy tank. This Pershing has received some improvised stowage baskets on both sides of the turret. **(Private Collection)**

**10** After the war the M26 was re-classified as a medium tank. About 1200 M26s were upgraded to M26A1 standard, with an improved M3A1 90mm gun, bore evacuator and a new muzzle brake. The M26 and M26A1 had a low cross country speed, and the main complaint made against the Pershing was that its Ford GAF 450 HP engine was underpowered for a 46-ton tank originally considered a heavy tank. Despite the fact that 2,000 M26s were manufactured during and after the Second World War, the scramble to find enough of them to send to Korea in 1950 was an embarrassing admission of how unprepared the Americans were for the conflict in Korea in 1950. On the battlefield the M26 proved easily capable of destroying the T-34/85s fielded by the North Koreans. **(Private Collection)**







**3. M48A1 Patton, '213' attached to 1ª Sección, 2ª Compañía, Regimiento Alcazar de Toledo, Ejército de Tierra, Spanish Sahara region, 1974.**

The vehicle is finished in overall Olive Drab (Vallejo 71.043 Olive Drab), with a patchy coat of Sand (Vallejo 71.138 Sand) oversprayed to the entire vehicle. Areas around the tactical numbers have been left bare.

**4. M48A1 Patton, Aleph 2 operated by the Israel Defence Forces, circa mid-to-late 1960's.** Finish is in overall Olive Drab (Vallejo 71.043 Olive Drab), with White and Black tactical markings.

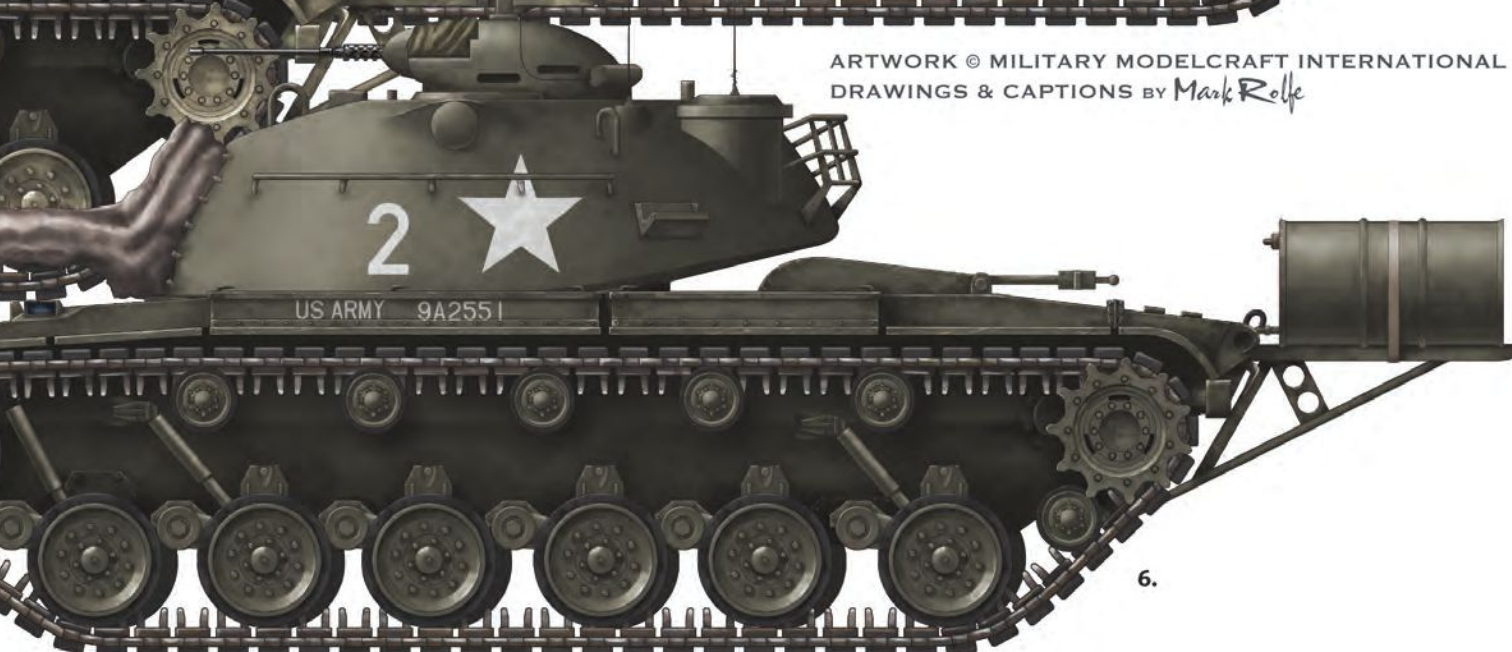
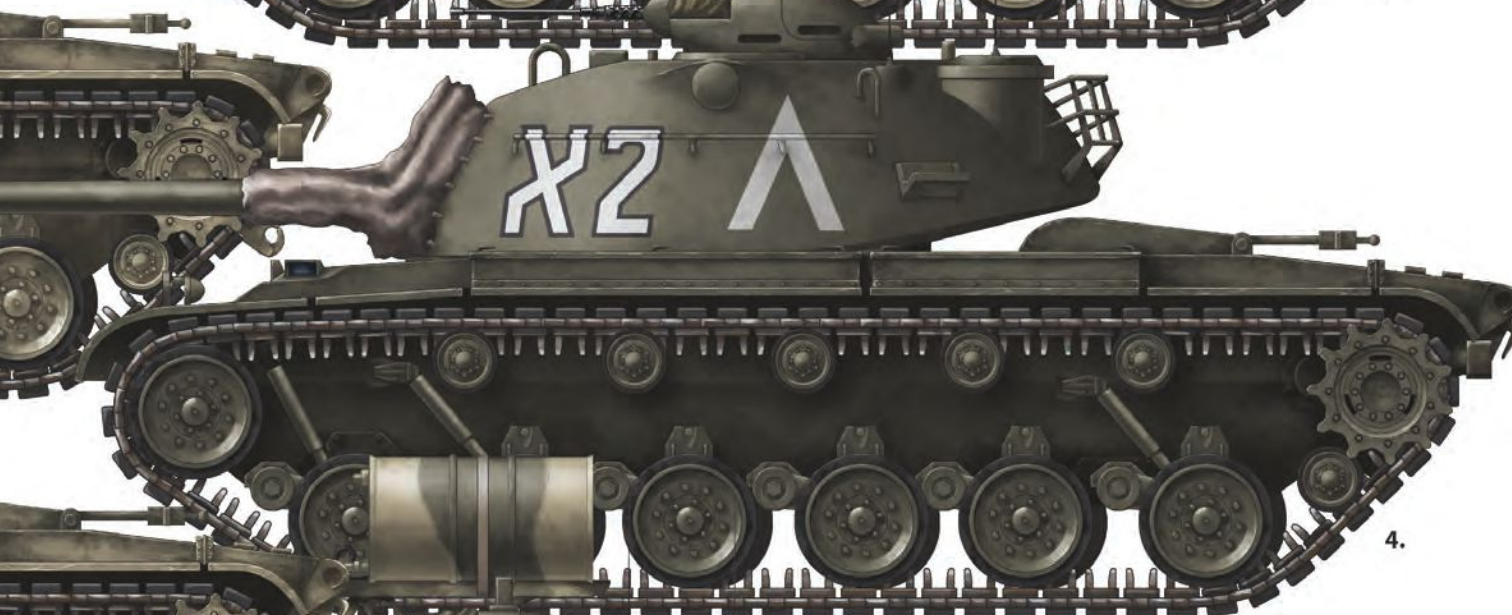
**5. M48 Patton, '50', attached to A Company, 2nd Battalion, 40th Armoured Brigade, 4th Armoured Regiment, Royal Jordanian Army, 1967.** The finish here is in overall Olive Drab (Vallejo 71.043 Olive Drab) with bands of Sand (Vallejo 71.138 Sand) applied overall. The tactical number (in Arabic) is carried on a Red and Yellow diagonally divided square.

**6. M48A1 Patton, '2', 9A2551, operated by the United States Army, mid-1960's** Finish is in overall Olive Drab (Vallejo 71.043 Olive Drab), with White tactical markings. Note the external tanks. Four drums were carried.



**1. M48 Patton, '12' 6th Armoured Division, Pakistan Army, Indo-Pakistan War, 1965.** Overall Olive Drab (Vallejo 71.043 Olive Drab), with areas of dried mud applied to areas of the hull, and turret. The tactical number is in Red, outlined in White. Note the White band applied to the turret as an identification measure, and also the three White bands applied to the gun fume extractor. These possibly denote the vehicle belonging to 'C' Squadron. Due to the poor range of early M48 variants, the external fuel tanks were a common feature. These could be jettisoned from within the vehicle in an emergency.

**2. M48 Patton, '535', operated by the Republic of Korea Army, Seoul, early 1970's .** Overall Olive Drab (Vallejo 71.043 Olive Drab), with areas of oversprayed Sand (Vallejo 71.138 Sand). The lightning bolt is in Yellow, with the vehicle tactical number in White. Note the Yellow pennant.



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DRAWINGS & CAPTIONS BY *Mark Rolfe*





These served in National Guard regiments as well as in US units in South Korea into the late 1980s. The definitive M60A1 served in Israeli units in the 1973 war and proved a match for Soviet T55 and T62s in Egyptian and Syrian hands.

The postwar American medium tank designs all enjoyed longer careers than had ever been expected of them at the time of adoption. The M48 and M60 in particular have proven to be fine combat

vehicles and proved to be superior in most respects to the Soviet contemporaries they would have faced had the Cold War turned hot. The number of vehicles in the Pershing and Patton families produced in American arsenals exceeded an impressive 38,000 vehicles. The US Armored Force employed this lineage of rugged vehicles for five decades, and many remain in service all over the world today.



**11** The M26 and M26A1 could be distinguished from the M46 by their original rear hull with the exhaust pipes exiting in the center of the rear hull face. The early days of the war in Korea saw successful North Korean use of the T-34/85 against the lighter American M24 Chaffees. In the summer of 1950 substantial American armoured forces equipped with large numbers of M4A3E8s and M26s deployed to Korea to redress the balance. (US Army)

**12** The M26, M26A1 and M46 were all vulnerable to hollow charge infantry weapons like any other tank of their generation, and some of these were encountered in battles with communist forces in Korea. This M46 dozer tank is equipped with chain link fencing around its turret as a precautionary measure. We can see the small track tension wheel below the sprocket that was introduced on the upgraded M46, a feature that remained in the M47 and original M48 suspension designs. (US NARA)

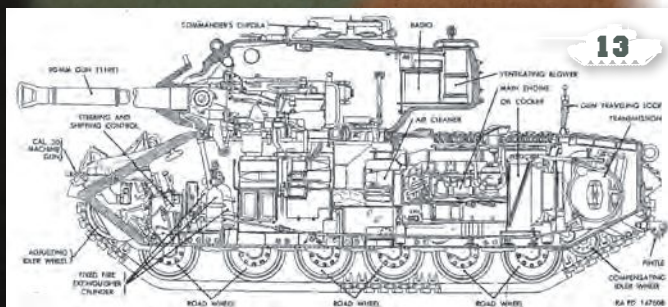
**13** A cut away of the M47 Medium Tank. The M47 was declared limited standard after only three years

of service in the US Army in 1955. M47s also served in all USMC Tank Battalions (entering service in the 1952-1955 period), but were retired in favor of the M48 and M103 combination in 1959. The US Army declared the M47 obsolete at around the same time. (US Army)

**14** An important trend in US tank design and procurement at the dawn of the 1950s was the concurrent development of two new medium tank types. These emerged as the M47 and M48 Medium Tanks, rushed into production during the Korean War and destined to suffer from the retention of old design features in the M47s case, and from a range of mechanical problems in the case of the M48. This is a US Army M47 on maneuvers in the mid-1950s. American use of the M47 was brief due to the more modern design characteristics of the M48, which featured thicker and better profiled armour. (Private Collection)

**15** The T42 design was sidelined as soon as the M47 had been approved for production in February 1951, and the M47 was dropped in its turn for the T48 90mm gunned medium tank. The result was that the US Army placed orders for the T48 (as the M48, also adopted in due course by the USMC) as soon as the design was proven, and while American armoured units were receiving their first M47s. Rejected so soon after standardization by the Americans, the M47 became an extremely important MAP export to friendly nations. The M47 served in 18 different NATO, SEATO and neutral armies before the Cold War ended. Throughout the first years of its service in conscript armies, the M47's fire control system demanded careful selection of candidates and substantial training to produce efficient gunners. It was nonetheless a comfortable, speedy and durable vehicle. The M47 was adopted by France, Belgium, Italy, Greece, Spain and the West German Bundeswehr when West German rearmament was permitted in 1956. It served as the basis for the new Panzerwaffe's battle tank strength alongside the M48A2 until the Leopard 1 replaced it in the late 1960s. (Private Collection)

**16** The M46 and M46A1 could be distinguished from the M26 by substantial changes to the exhaust system and rear hull plate. This colour photo shows some of the steep terrain encountered in Korea. The modified







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tanks were nicknamed in honour of General George S. Patton. **(US NARA)**

**17** A photo of the headquarters squadron of the US Army's 63rd Tank Battalion in West Germany in 1955 or 1956. The M47 had a complicated development history: the T42 Medium Tank expected to replace the M4A3E8, the M26 and the M46 in US service was delayed in entering production by the need to incorporate numerous improvements to the hull design. The United States Army pushed instead for the immediate production of a new tank combining the T42's turret with the existing M46A1 hull with an enlarged turret ring (designated M46E1). This stop-gap was considered satisfactory for the production

of the tank for immediate needs- despite the retention of archaic features like the co-driver/hull machine gunner's position. The resulting M47 Patton entered production in June 1951 but was not standardized until May 1952. Built at the Detroit Tank Arsenal and at ALCO, the new turret's fire control system was far more complex than its predecessors and it suffered numerous teething troubles. It arrived in regimental service in the summer of 1952 but was never deployed in action during the Korean War. By the time production of over 9,000 M47s ended in November 1953, the new tank was already fated to see a very short career in the United States Army. **(Pam Morris)**



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**18** The T43 heavy tank, later standardized as the M103, was developed at around the same time as the M47. Its design greatly influenced the armour layout of the T48 medium tank hull. Like the M46, M47 and all original production M48s, the M103 employed a gasoline engine, which gave it a short operational range. The US Army's use of the M103 proved to be brief, but the USMC kept the M103 in service until the early 1970s, rebuilt with the M60's diesel engine. *(Private Collection)*

**19** An M48A1 driving through the US sector of West Berlin followed by an M75 APC during the Berlin crisis. The famous Mexican standoff at

Checkpoint Charlie was an iconic moment in the Cold War. This was the first test of the mettle of President Kennedy's administration. *(CIA Photograph)*

**20** The T48 was a promising design and it was ordered into production prematurely like its predecessor due to the Korean War. The M48 quickly eclipsed the M47 in the US Army and in the USMC. The 49-ton M48's hull and turret were produced as complete castings and these designs owed much to the influence of the T43 heavy tank's armour layout. There were a minimum of shot traps, and attention paid to the hull's ability to resist antitank mines as well as armour piercing rounds. The driver sat in a central location in the hull front unlike in its M26-inspired predecessor. Turret was a dome shaped casting with 178mm frontal thickness and its fire control system was also based on the use of an improved M17 coincidence rangefinder. The gun was still a 90mm piece derived from the M3 of 1944 vintage, now designated T54 with an improved muzzle brake and ammunition. The tank commander was provided with an armoured machinegun cupola equipped with a .50 calibre M2 Browning heavy machinegun from the M48A1 onwards. Over 12,000 M48s were built by the time production ceased in 1959. *(US Army)*

**21** The M48 was built by Chrysler, Ford Motor Company, ALCO and Fisher Body division of General Motors. This M48's 90mm gun barrel carries the T-shaped blast deflector, and the tank commander was provided with a simple cupola with an exterior mounting for the M2 Browning heavy machinegun. Without the mantlet cover fitted, we can see the large gun mantlet, angled to deflect projectiles upwards. The original M48, M48A1 and M48A2 all had gasoline engines, fitted with the Continental AVSI-1790-6 producing 810 HP. The powertrain suffered from high fuel consumption and the early M48s were inferior in cross country performance to the M47s they replaced, despite their use of an improved suspension. *(US Army)*

**22** The M1 cupola, the early pattern suspension and the original engine deck of the M48A1 are all visible in this picture. This vehicle is fitted with a Crouse-Hinds search light. The M48A1 was sometimes equipped for auxiliary fuel drums on a platform fitted on the hull rear. The M48A2 introduced a number of improvements to the suspension and powertrain but these were not enough in themselves to achieve the level of reliability that the armoured force required. The old M47, which could reach speeds of nearly 40 miles per hour, easily outstripped the M48s when operated alongside each other in Europe. The risks of engine fire and of running out of fuel were also high in the early M48s. *(CIA Photograph)*

**23** The T48 design's hull and turret shapes were a complete departure from previous US Medium Tank designs, and were heavily influenced by the T43 Heavy Tank. *(US NARA)*

**24** The T48 included a larger turret ring than the M47 series. The dome shaped turret and elliptically-



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shaped hull gave the T48 design a well-profiled armour layout. (US NARA)

**25** The M48A2 introduced a number of improvements to the suspension, powertrain and fire control system. The M48A2 was also exported to West Germany in the late 1950s and remained in service for thirty years in original and also in locally rebuilt and up-gunned forms. Many of the West German vehicles were transferred to Israel after the Leopard 1 became available in quantity in the early 1970s. (Private Collection)



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**26** The M48 series could also be fitted with a dozer kit. (*US Navy*)

**27** An M48A3 in Vietnam. The M48A3 rebuild program introduced in 1963 eventually rectified the M48's mechanical and short range

problems. Both the US Army and the USMC employed the M48A3 in Vietnam, where it proved highly effective as an infantry support weapon. The M48A3 was

a rebuilt M48, M48A1 or M48A2 fitted with improved fire controls and AVDS-1790-2 diesel engine. The M1 cupola was normally raised with a spacer ring fitted with episcopes that permitted the commander to better observe the battlefield around him. This vehicle was likely rebuilt from an M48A1, as can be divined from its five return rollers on each side. (*US NARA*)

**28** The M60 was the United States' first real Main Battle Tank, and as seen here with its original turret, its similarity to the M48 is plain to see. Its M68 105mm gun was an American-produced version of the Royal Ordnance L7 gun, with many changes and improvements to suit US Army requirements. The M60 program also served to introduce many of the retrofitted improvements applied to the large M48 park. In its original form, the M60 employed an up-gunned M48A2 turret and a new hull design employing cast and welded sections. The M60 was more heavily armoured than the M48 series and it introduced the excellent AVDS-1790-2 diesel engine. It replaced both the M103 and the M48 series, although the latter was rebuilt into the M48A3 and up-gunned as the M48A5. The M48A3 served the US Army in Vietnam and the M48A5 remained in service in the armored corps and in the National Guard until the late 1980s. (*US NARA*)

**29** The M60 was extensively developed and its derivatives (M60A1 and M60A3) served the US Army and USMC right up to the 1991 Gulf War. This is an M60A1 in service with the US Army in the 1970s. The M60A3 that followed incorporated a laser rangefinder and an improved fire control system. (*San Diego Air and Space Museum Collection*)



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**30** The M48 soldiered on in Allied armies well into the 1980s. This South Korean M48 was pictured during Exercise Team Spirit in 1984. *(U.S. Army/SPC Long)*

**31** U.S. soldiers from 25th Infantry Division supported by a South Korean M48 during Exercise Team Spirit 84. *(U.S. Army/Dac Al Chang)*

**32** U.S. Marines aboard an M48A3 sweeping the road southwest of Phu Bai, Vietnam, in April 1968. *(NARA)*

**33** Another camouflaged South Korean M48 on exercise. *(U.S. Army)*



**31**



**32**



**33**



# ARMOUR IN PROFILE

M.P. Robinson looks at the **Return of Forces to Germany** exercises during the Cold War.



## REFORGER: 1968 - 1988

In the second half of the Cold War the United States conducted roughly annual exercises to deploy and reinforce the three army corps of the 7th U.S. Army based in West Germany. The III Corps was based in times of peace in the United States, whereas the V and VII Corps included a portion of

their total strength on U.S. bases, earmarked for return to West Germany in the event of war. In the event of war, the United States expected to be able to move a force of six divisions and over fifty air squadrons from the continental United States to Western Europe, a monstrous undertaking. REFORGER

developed and tested the capability of the United States to move complete units and to test the mettle of its officers and men in combat scenarios they might have encountered defending the 7th Army position in wartime.

The concept of air and sea lift reinforcement of West Germany in a short time had already been practiced previous to REFORGER 1. Most famously in November 1963 the U.S. Army and U.S.A.F conducted the ambitious Exercise Big Lift, which transported the men of the 2nd Armored Division from Fort Hood Texas by air lifts to man pre-positioned AFVs in West Germany. The division then conducted a week long field exercise (playing as Orange Force) to defend the West-German-Czechoslovak and the inner German border.

The U.S. 3rd Armored Division played the role of the Warsaw Pact forces (Blue Force) with Bundeswehr units under command. The whole exercise was conducted under the command of General Creighton Abrams and it served as much as a warning to the Soviets after the Berlin Crisis as an exercise in logistics. The degree of hostility between the NATO and Warsaw Pact camps at the time required regular shows of military force in the form of large mechanized manoeuvres. The Cold War was in full swing.

Big Lift provided the U.S. Army with plenty of lessons on how to conduct a major strategic airlift, but also showed the army that moving a division alone by air would not suffice to shore up American numbers in Europe. Moving





a larger force could only function if its weapons were already pre-positioned in West Germany. Moving equipment across the Atlantic required a well-honed sea-lift capability executed months in advance to position equipment where it would be required. Transport aircraft availability, fighter cover, adequate landing areas, and even the availability of adequate training areas all bedeviled the planning of airlift operations in the 1960s. The rapid reinforcement concept prevailed as a vital component of American military doctrine despite its expense and the vulnerability of air and sea lifts to enemy interception. The mass airlift concept was enlarged (impressing the U.S. civil airliner fleet) and synchronized with sea lifts of troops and vehicles directly from American ports by the USN. Local exercises conducted by key allies in the NORTHAG and CENTAG commands would coincide with American operations to test interoperability.

The first REFORGER exercise was a demonstration of American commitment to its strategic position in West Germany despite the manpower requirements of operations in Vietnam. The planning for REFORGER 1 began in early 1967 and took over a year. REFORGER 1 was preceded by a sea lift of equipment, followed by the two-week long air lift of some 12,000 men of the 24th Infantry Division to West Germany. Winter maneuvers followed and plans were made to expand the process in the following year. After the success of the

first REFORGER the exercise became a recurring event held in September or January for the next two decades. REFORGER exercises progressed into ever more complex and ever more intricately planned displays of military power. The key to making REFORGER function as a long term reinforcement strategy was the storage of three divisions worth of carefully maintained equipment at sites in Europe. The storage sites, stocks and procedures were part of an ongoing logistic process known as POMCU.S. (Prepositioning of Materiel Configured in Unit Sets).

REFORGER 1 reminded the Warsaw Pact that America could move massive air and ground reinforcements to West Germany at short notice. There was a steady annual increase in the size of the REFORGER exercises after the winter REFORGER IV exercise of January 1973. Up until this time the size of the American contingents sent to practice the reinforcement strategy were only of divisional size. The first five REFORGER exercises did not follow a strictly annual schedule (there was no REFORGER exercise in 1972, but two were conducted in 1973). A notable exception to Army participation in the ground exercises was the historic deployment of elements of the 2nd Marine Division during REFORGER 75. The reinforcement of U.S. air power in West Germany from bases in the USA featured largely in each exercise. From 1974 onwards the exercises steadily grew to corps-sized exercises. Exercises planned

**1** Sea Lift operations were vulnerable to submarine and air attack, and demanded careful preparation of port facilities on both sides of the Atlantic. This was photo was taken during REFORGER 85. (U.S. Army)

**2** M60A1 and M60 Bridgelayers under maintenance in Schweinfurt in 1972. Although these vehicles were part of the equipment of the 3rd Battalion, 64th Armored Regiment, the scene gives a good idea of the mechanical feats necessary ahead of each REFORGER exercise, and what it took to keep the equipment held in POMCU.S. sites operational. (Raymond Fudge)

**3** Vehicle movement exercises in West Germany, where possible, made the most of railways to minimize congestion and damage to the road system. These M60A1s of the 3-64 Armor

are seen being chained down to railway flats in 1973 at the railhead at Conn barracks, Schweinfurt. REFORGER exercises resulted in a hefty bill from damaged civilian property. (Raymond Fudge)

**4** An M151 MUTT of the 703rd Maintenance Battalion during REFORGER 75. (Raymond Fudge)

**5** An M60A1 of the Schweinfurt-based 3-64 Armor during REFORGER 75. Note the characteristic camouflage pattern and low-visibility markings. Not all of the battalions' tanks wore disruptive camouflage patterns, in 1974-75 a number of olive drab painted vehicles could still be seen. (Raymond Fudge)

**6** Heavy transport vehicles of the 703rd Maintenance Battalion, REFORGER 75. (Raymond Fudge)







**7** M113A1s of one of the Blue Force units rumbling down the main street of a picturesque West German village during REFORGER 84. (U.S. Army)

**8** A military policeman directing an M60A1 on a West German roadway during REFORGER. The importance of traffic control in such massive manoeuvres cannot be underestimated. (U.S. Army)

**9** State of the art vehicles like the M3 Bradley IFV seen here were extensively employed by American mechanized

infantry units participating in the REFORGER exercises. The American infantryman of the early 1980s wore a mixture of old and new: the M1 Helmet, ALICE webbing and woodland pattern BDU.S. were typical for the 1983-1985 period. (U.S. Army)

**10** Several of the REFORGER exercises were conducted in the cold of a German January. This Blue Force M60A1 is equipped with a fire simulator and carries a spare roadwheel on top of the gun mantlet. (U.S. Army)



in the V Corps and VII Corps areas under the larger umbrella of the annual REFORGER simulated mechanised battles in strategically vital areas and the ability of each unit to fulfill its tactical missions was carefully noted by umpires and observers. In NORTHAG operations of divisional size were usually undertaken by BAOR at the same time (Exercise Crusader in 1980 and Exercise Lion Heart in 1984 were the two best known reinforcement exercises for I British Corps). REFORGER grew into a 120,000 man show of force and logistic expertise by 1988. Air and Army National Guard units featured as supporting units or as complete formations (up to Brigade size) in the REFORGER exercises held in the 1980s.

REFORGER was a reassuring show of U.S. commitment to its NATO allies. There is evidence that REFORGER exercises were realistic enough to severely shake up Soviet military intelligence. On at least one occasion (REFORGER 83) the Soviet Union actually interpreted the rapid buildup of corps-sized reinforcements as a possible prelude to a pre-emptive NATO strike. This was because by the mid-1980s a REFORGER exercise included all of the hallmarks of the 'real' military operations they practiced: secret coded communications, synchronized air and naval exercises in Europe (and in other potential theatres of war), and the large scale participation of key allies.

The cost of these exercises

were naturally extremely high, but the long term development of American rapid reinforcement capability had a strong deterrent effect in itself. Armoured divisions, armoured cavalry regiments, mechanised infantry divisions, and airborne divisions all served in these exercises. How did REFORGER serve to train the command staffs, officers and men of the United States armed forces? One has only to look at Operation Desert Storm in 1991 to see how the impact of large scale military exercises forged American capabilities to execute large scale conventional military operations at great distance from the USA. Nowadays the huge REFORGER exercises are a memory for all who witnessed or participated in them.

#### **Certain Challenge 88**

Below is a sampling drawn from a list of marking codes employed by units in REFORGER 88's Exercise Certain Challenge. It is organized by units involved, taken from an exhaustive list supplied kindly by Cookie Sewell. The two corps involved, as per the tradition established in the 1960s, operated as Blueland and Orangeland.

#### **A Sampling of Markings for Units Involved in Exercise Certain Challenge during REFORGER 1988:**

**V Corps** (Blueland or Northland): black numerals on blue background panel

**1/11th Armored Cavalry Regiment:**





- Headquarters: 170
- 1 Squadron: 171
- 2 Squadron: 172
- 3 Squadron: 173
- 11 ACR Aviation Squadron: 174
- 11 ACR Combat Support Squadron: 175

#### 3rd Armored Division:

- HHC and Support: 330

#### 2nd Brigade:

- HHC and Support: 320
- 3/8 Cavalry Battalion: 321
- 1/48 Infantry Battalion: 322

#### 3rd Brigade:

- HHC and Support: 330
- 4/67 Armor Battalion: 331
- 2/36 Infantry Battalion: 332

#### 3rd Division divisional artillery:

- 4/82nd Artillery Battalion: 351
- 2/82nd Artillery Battalion: 352

#### 3rd Armored Cavalry Regiment (reinforcing unit from USA):

- HHT and Support: 370
- 1st Squadron: 371
- 2nd Squadron: 372
- 3rd Squadron: 373
- Aviation Squadron: 374

#### 29 Panzer Brigade:

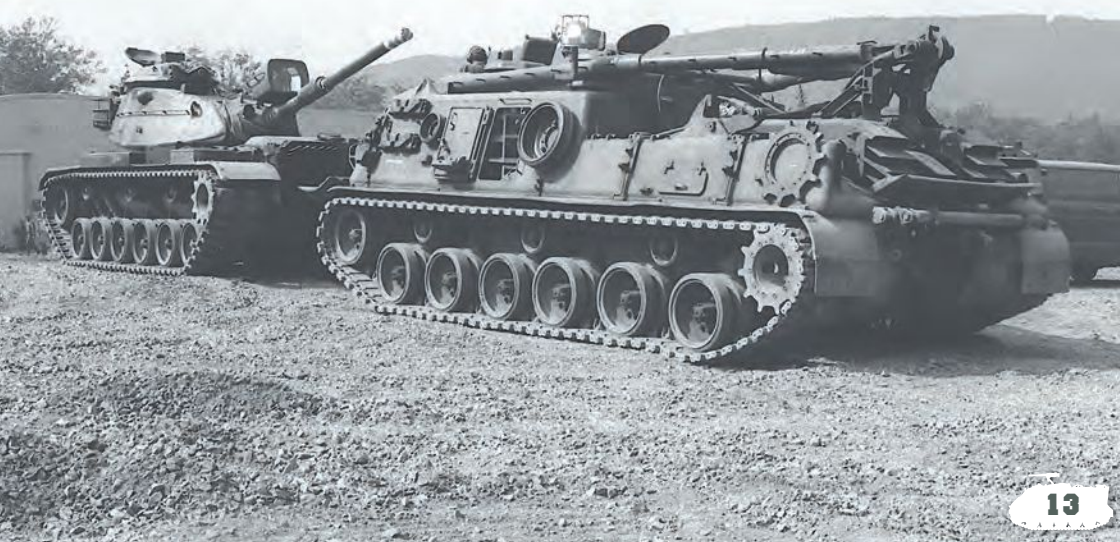
- Stabskompanie: 920
- 291 Panzer Btn: 921



**11** An MLRS system deployed during REFORGER 84, which included Spearpoint 84 as one of its phases, one of the largest BAOR exercises of the Cold War. *(U.S. Army)*

**12** Helicopters, a vital part of United States operational doctrine after the hard lessons of Vietnam, were part of all Armored Cavalry Regiments and featured in every REFORGER exercise. These are AH-1G Cobra attack helicopters parked on a frosty German landing field. *(U.S. Army)*





- 292 Panzer Btn: 922
- 293 Panzer Btn: 923
- 294 Panzergrenadier Btn: 924

**VII Corps** (Orange Land or Southland): black numerals on orange background panel

#### 1st Infantry Division

(reinforcing unit from USA):

- HHC and Support 101

#### 1st Brigade 1st ID

- HHC and Support 110
- 1-34 Armor BN 111
- 2-34 Armor BN 112
- 5-16 Infantry BN 113
- 2-128 TLAT BN 114  
(M966 Hummer)

#### 3rd Brigade 1st ID

(Permanently Based in Germany)

- HHC and Support 130
- 1-16 Infantry BN 131
- 4-16 Infantry BN 132
- 3-34 Armor BN 133

#### Division Artillery, 1st ID

- HHB and Support 150
- 2-5 Artillery BN 124  
(With 1st ID Forward)
- 1-5 Artillery BN 151
- B Battery 6th FA 152  
(Multiple Launch Rocket System)

#### 2nd Armored Cavalry Regiment

- HHT and Support 270
- 1st Squadron 271  
(1/2 ACR)
- 2nd Squadron 272  
(2/2 ACR)
- 3rd Squadron 273  
(3/2 ACR)
- Aviation Squadron 274  
(4/2 ACR)

#### 3rd Infantry Division

- HHC and Support 601

**13,14** Naturally, breakdowns were not unknown with so many AFVs seeing hard use. An M60A1 being assisted by an M88 recovery vehicle during REFORGER 78. (*U.S. Army*)

**15** The Bundeswehr participated in some capacity in all of the REFORGER exercises. This Leopard MBT was photographed during REFORGER 1983. (*U.S. Army*)

**16** American mechanised infantry deployed the M3 Bradley Mechanized Infantry Combat Vehicle in REFORGER 85. By the middle of the 1980s American formations were introducing the new Bradley and M1 Abrams MBT, and by the end of the Cold War they held a qualitative advantage over their potential opponents. (*U.S. Army*)



#### 1st Brigade 3rd ID

- HHC and Support 610
- 3-64 Armor BN 611
- 1-15 Infantry BN 612
- 1-69 Armor BN 613

#### 2nd Brigade 3rd ID

- HHC and Support 620
- 1-64 Armor BN 621
- 1-30 Infantry BN 622
- 2-30 Infantry BN 623

#### Division Artillery, 3rd ID

- HHC and Support 650
- 5-41 Artillery BN 651
- 3-39 Artillery BN 652
- A Battery 1-72 653
- Artillery (MLRS)

#### 35th Panzergrenadier Brigade

- Stabscompagnie 980
- 351 Pz Gr BN 981
- 352 Pz Gr BN 982
- 362 Pz Gr BN 983
- 354 Pz Gr BN 984

#### 4th Canadian Mechanized Battle Group, CFE

- HHC and Support 990
- 2nd BN, PPCLI 991
- 8th Canadian Hussars 992
- 2/ Royal 22e Régiment 993

This photo essay is a humble tribute to all the U.S. servicemen and NATO allies who took part in the REFORGER exercises.

The author thanks Dan McManus, and Raymond Fudge for the use of their photos, and Cookie Sewell for providing the markings list for Certain Challenge in September 1988.



**17** The M60A1 was the workhorse of American armored units in the USA and in West Germany throughout the 1970s and 1980s. This is 'Combined Effort' from C Company, 4-73 Armor Regiment from the 1st Infantry Division in 1977. In the event of war the 1st Infantry Division, based at Fort Riley Kansas, was earmarked to airlift to the VII Corps in West Germany. It would collect its vehicles from the POMCUS depots in the Mannheim area. (Dan McManus)

**18** An Orange Force M60A3 being guided across a Medium Girder Field Bridge by combat engineers in 1983. The crossing of major waterways was normally part of every REFORGER exercise. (U.S. Army)







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**19** A German couple pass a parked M2 Bradley IFV from 7th Infantry Division during Exercise Central Guardian, part of REFORGER 85. (*U.S. Army*)

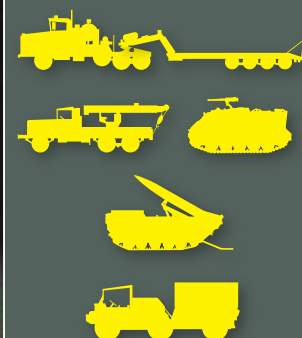
**20** An M901 TOW vehicle seen during REFORGER 82. (*U.S. Army*)

**21** The first M2 Bradley IFV to be drawn from a POMCUS site is driven out of a warehouse in preparation for Exercise Spearpoint, part of REFORGER 84. (*U.S. Army*)

**22** M110A2s unloading from a Sea Lift Command transport ship. Armed with the M115 203mm gun, the M110A2 and MLRS systems deployed in U.S. divisional artillery regiments could destroy enemy armoured concentrations at long range. (*U.S. Army*)

**23** Orange Force M110A2s of the 40th Artillery deployed along a West German treeline REFORGER 85, in January 1985. (*U.S. Army*)

**24** An M578 Recovery vehicle motoring down a German road during REFORGER 84. These light ARVs could be found in mechanized infantry and in self-propelled artillery units. (*U.S. Army*)



**REFORGER  
 1968-1988**









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**25** Members of the 11th Armored Cavalry exit their M113, while a M551 Sheridan stands guard nearby near the East German border. *(U.S. Army)*

**26,27** M1 Abrams of 2-64 Armor, 3rd Infantry Division, play the role of Blue Force during Exercise Carbine Fortress, part of REFORGER 82. This was the first occasion on which the M1 was fielded. *(U.S. Army)*

**28** 28 U.S. soldiers in M113 armoured personnel carriers cross the River Rhine during a REFORGER exercise. *(U.S. Army)*

**29** 25 Two M1 Abrams move along a dirt road during REFORGER 85. *(U.S. Army)*

**30** 26 An M1 Abrams of Company D of 1-11 Cavalry Regiment takes part in Exercise Autumn Forge, part of REFORGER 83. *(U.S. Army)*

**31** 27A well-stowed M1 during a REFORGER exercise. Note the 155mm ammunition stowage tubes on the turret side which were used to store maps and personnel belongings. *(U.S. Army)*





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**31** M113 APCs of the 32nd Separate Infantry Brigade (Mechanized) waiting to be loaded aboard the vehicle cargo/rapid response ship USNS Antares at the end of REFORGER 86. Note the characteristic and colourful Mobility Equipment Research and Development Center (MERDC) camouflage scheme. (*U.S. Army*)



**32** A M113 of 1st Cavalry Division drives through the Belgium town of Visé after crossing the River Maas during Exercise Autumn Forge in 1983. (*U.S. Army*)





# ARMOUR IN PROFILE



M.P Robinson celebrates the mighty M60 Main Battle Tank.



## LAST OF THE PATTONS

The venerable M60 was standardized in March 1959 by the US Army, and entered production as the world's first purpose-designed production Main Battle Tank. Some will argue that the Centurion, which was the first to carry the L7 105mm gun, could hold the title of the first Main Battle Tank, but it was initially designed as a cruiser tank, became a Medium Gun Tank when the 20-pdr was developed, and subsequently most were retrofitted with the 105mm gun to become Main Battle Tanks, often five to ten years after manufacture. The M60 series were expected to serve the Main Battle Tank role right off the drawing board.

**1** The M60A1 introduced a more heavily armoured, more efficiently profiled and slightly larger turret in 1962. The M60A1 made up the vast majority of all M60s produced. (Joe Cottone)

Over 15,000 M60 series Main Battle Tanks were produced and the type went on to serve the USA into the 1990s. It beat the Chieftain, Leopard and AMX30 into service by five or six years and it continues in use in many armies right up to the present day. It bore the classic features of a lineage that stretched back to the M26 of 1944: a powerful main armament, heavy armour and good mobility. The M60 earned its reputation as an effective family of combat tanks that bested the T55 and T62 in most encounters during the 1973 Yom Kippur war. This war made Continental Europe's tank designers re-examine their design priorities and confirmed the importance of protection and firepower in American tank design. Its gun proved effective against any opponent it was called upon to fight. The M60's excellent powertrain proved adaptable

and was widely adopted in Israeli designs to improve tanks like the Centurion and to power their own Merkava. The M60 program also yielded many improvements that were then applied to the M48A3 and M48A5 to keep older vehicles in service for decades. By any measure, the M60 was a successful tank design, one of the finest of the Cold War era, but one seldom recognised for its overall excellence.

### The T95, the T60, and M60.

In the mid-1950s the United States Army was developing a lighter, more powerfully armed, more mobile and better armoured successor to the M48, itself a newly standardised medium tank. This was the T95, a visionary design with tremendous potential, and one that incorporated a great deal of new technology. The T60 was a modernisation of the M48A2,

developed from a United States Army requirement for a lower risk medium weight tank alternative to the T95 program and was instituted in mid-1957. The objective of the T60 program was to bring a universal or Main Battle Tank into service with significant improvements over the existing M48A2 within a short time and employing available technology (and M48 derived components) wherever possible. The Main Battle Tank concept was intended to replace the M48 Medium Tank and M103 Heavy Tank with one heavily armed, highly mobile battle tank in the 40 to 55-ton range. The T60 was not originally expected to supersede the T95 program, but rather to supplement the existing M48 fleet as a short-term solution to getting an effective counter to the Soviet T54 into service. At the time the T60 program started, the more





**2** The original M60 seen here bore a strong family resemblance to the M48A2. The original turret and gun shield configuration were very much a modernization of the M48's arrangement. *(Frank Moseley)*

**3** The rear end of the M60 also bore a strong resemblance to a late model M48, despite the updated suspension and the introduction of the new diesel engine. *(Frank Moseley)*



**4** The M60A1 retained the same commander's cupola and rangefinder employed on the M60. These M60A1s were photographed in glossy

olive drab in 1967. *(Joe Cottone)*

**5** The M60A1 was deployed very widely in the USA and in West Germany as soon as numbers permitted.



The type was never employed in the Republic of Viet Nam but a wide range of improvements introduced on the M60A1 were included in the M48A3 upgrade of older M48s in 1964. *(Joe Cottone)*

**6** An M60A1 in the iconic camouflage pattern carried on many US AFVs in the 1970s before the Mobility Equipment Research and Development Center (MERDC) camouflage pattern systems were introduced. Seen in 1975, these are closeups of a tank of 64th Armored Regiment based at Schweinfurt. This photo was taken at a base Open Day. *(Raymond Fudge)*

advanced T95 was still expected to be produced and brought into service in the early 1960s.

The fundamental advantages enjoyed by the T95 over the M48A2 lay in its use of a diesel engine and in its superior fire power. The Army Bureau of Budget saw the M48 series as costly to operate and in need of modernisation or replacement as soon as possible. The quickest means of improving the situation was to replace the M48A2's gasoline engine with a related Continental product, the AVDS-1790-2, which was simple to place in production and was a relatively mature design. The 750 HP engine was mated to an effective transmission, the CD-850-6, which gave the vehicle far better fuel economy than the M48A2 and a range of nearly 500km.

In 1958 the decision was taken to develop an American version of the Royal Ordnance L7 105mm gun, which became the T254. The British 105mm gun had been developed during the 1956-57 scare caused by the inspection of a T54 on the British embassy grounds in Budapest during the Soviet intervention in 1956. It had been achieved by the simplest of means-by increasing the bore of their existing QF 20-Pounder, an 83.4mm gun of similar dimensions to the M48's US 90 mm M41 gun. The T254 was adopted as the M68 after extensive testing by the US Army in 1958, and the M116 gun mounting was adapted to the M48A2 turret casting. The M48A2C was still in production at the time and extensive testing was accomplished on modified M48A2s to develop the new tank. This choice of gun simplified the T60's development considerably (although many changes to the M48A2 turret to suit the T60 were required, including a larger cupola ring).

Like the M48 series the T60 would employ an enclosed commander's cupola, albeit one much larger than the M1 cupola fitted from the M48A1 onwards-a feature that production M60s retained right up to retirement from American service in the 1990s. The T60 turret's frontal armour (as per the M48A2C) was a maximum of 180mm thick and 54 105mm rounds could be



carried for the main armament.

The T60's cast hull was also based on the general layout employed on the M48A2, with some significant alterations. The most noticeable feature was the adoption of a flat glacis slope, compared to the rounded hull front seen on tanks like the M103 and M48 series. The T60's hull's frontal armour layout was roughly 100mm thick, and to save weight aluminium was used extensively for the road wheels. The driver, located in the middle of the front of the hull, enjoyed the same ease driving the T60 as its predecessor the M48. A floor escape hatch was provided immediately behind his seat.

The T60 was intended to be able to move and fight at night and was built with night driving in mind right from the start. The driver was provided with three periscopes, the middle of which could be replaced with a M24 infrared vision device. It carried a large Xenon light projector on the gun mantlet in a similar installation to the Crouse Hinds searchlight carried on the M48A2 and infrared sights were provided for the gunner and commander.

The T60 designation was changed to XM60 during the last months of 1958, and was standardised as the M60 in March 1959. It was ordered into production by the end of the year, carrying the Patton nickname used on the M47 and M48 forward, but was never officially to bear that name. The first 360 M60s were built in Delaware at the Chrysler Newark plant, and nearly 1700 more were manufactured at the Detroit Tank Plant.

#### M60A1

The first M60s entered service at the end of 1960. With the M60 in production, the next two years were spent adapting the best features of the T95's turret to the M60 design, which resulted in the M60A1, first produced in mid-1962. An estimated 12,000 M60A1s were built and the type remained in production for about two decades (the monthly deliveries increasing after 1973 in response to the need to have a reserve of vehicles in case of crisis or war). The new turret had a maximum frontal armour



**7** Some 200 M60s and M60A1s were supplied to Israel after the 1967 war and they formed a significant portion of Israel's armoured force during the 1973 war. (*Israeli Government Press Office*)

**8** In combat the M60 and M60A1 both proved survivable and effective designs, but some weaknesses were also identified. One serious problem was the use of highly flammable hydraulic fluid in the M60's hydraulic system. This caught fire if the armour was penetrated, and was a flaw rectified quickly afterwards in US and Israeli upgrades. (*Israeli Government Press Office*)

**9** M60A1s of the Israeli army advance towards the Suez Canal in the 1973 Yom Kippur War. (*Israeli Government Press Office*)

**10** Against the T-55 and T-62 the M60 and M60A1 proved

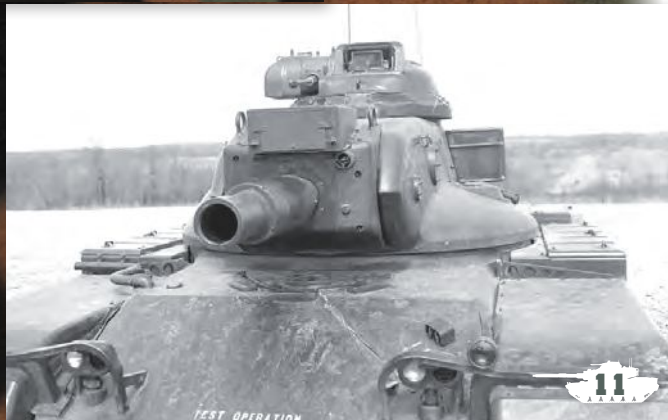


themselves repeatedly. The M60 series had far better ergonomics and often individual Israeli M60 crews knocked out multiple Egyptian or Syrian opponents. An effective remedy to the RPG and ATGM developed in the late 1970s in Israel was the Blazer reactive armour system, adopted by the Israeli and American forces. The M60 series,

known like its M48 predecessor in Israeli service as the Magach, were first used in combat with this system in 1982. Note how the Israeli M60A1s upgraded here have replaced the original cupola with the Urdan type manufactured in Israel. (*Israeli Government Press Office*).







**11** In the 1960s the Americans also embraced the ATGM, both as an infantry or air launched weapon... and also in the form of the Shillelagh gun/missile main armament for the M60A2 series. This prototype, known as the M60A1E1, began testing in 1964. *(US Army)*

**12** A more advanced version of the same launcher vehicle was designated M60A1E2. The testing phase was beset with problems and it took 10 years to get a Shillelagh armed M60 into service. *(US Army)*



thickness of 250mm, and was longer, with more crew space. There was increased stowage for 58 rounds of 105mm ammunition. The M60A1 introduced a 120mm thick glacis, an improved powertrain, improved crew positions and an improved suspension. Last of all, the M60A1 introduced new fire controls and improved combination (day and infrared) sights for the commander and gunner. This was the definitive version of the M60 family, which retained the optical rangefinder system of the M60 in improved form, but it still lacked an effective gun stabilisation system.

At around the same time that the M60 entered production, the T95 program was sidelined and eventually cancelled.

The M60's introduction also speeded the M103 heavy tank into retirement, except in the United States Marine Corps (where it was adopted with the significant substitution of the M60's AVDS-1790 engine and cross-drive transmission). The M48A3 was largely improved as a result of the M60's component and drivetrain development. It was improved subsequently in the 1970s into the M48A5 as the M60A1 underwent modernisations.

The adoption of the L7 gun in the UK and its modification for American use as the M68 was a fundamentally important event, because it caused nearly every army that benefitted from American generosity in ammunition production to adopt compatible L7 or M68 based weapons either produced by the British, in the USA or under license from either nation. This influenced the adoption of this type of 105mm gun across nearly all the NATO nations for tanks introduced in the 1960s (with

**13** The M60A2 was known to its crews as the Starship due to its advanced electronics, and it served in separate armor battalions due to its complexity. The colour photo shows three M60A2s of the 1-67 Armor. *(US Army)*

**14** An M60A3 of the 3-32 Armor during REFORGER 1986 in West Germany. The M60A3 had some of the features introduced in the M1 program and was popular with its crews for its ability to fire on the move and its more advanced optics. *(US Army)*

the exception of the French, although the British ironically retired their 105mm armed Centurions between 1967 and 1972 in favour of the Chieftain armed with an L11 120mm rifled gun). The M60 series was adopted in Italy, Israel, Spain, Greece, Turkey and many other friendly nations. The 1970s saw many incremental improvements added during the M60A1 production run and to vehicles which were rebuilt. The most significant came in 1972, a gun stabilisation system to give the M60A1 a fire on the move capability at long last. Besides the add-on gun stabiliser other improvements included new tracks and top-loading air cleaners.

#### **M60A2**

The M60A2 was the problem child of the M60 family, with an exceptionally long development time complicated by the fact that its main armament was beset with teething problems. The T95 was succeeded in the US developmental pipeline by the MBT70 concept and here American-West German co-production and co-development proved extremely difficult to coordinate. The MBT70 pursued between 1963 and 1971 was based on innovative, high risk technology and the armament system chosen to arm the American version spilled over into both the air-transportable tank concept (M551) and into the M60 program.

The Ford MGM51 Shillelagh Guided Missile Gun system chosen to arm the US MBT70 was adapted to a special turret designed to be mounted on a standard M60A1 hull in 1964 as the M60A1E1. The MGM51 employed an infrared guidance system, which proved difficult





to perfect and difficult to adapt to an MBT fire control system. It also had tactical limitations in an armoured battle. The Shillelagh missile was a weapon that required line of sight control throughout its flight onto its target, which required the gunner's full concentration at the expense of any sudden threat or any subsequent target acquisition. Other problems were encountered in the combustion of the 152mm conventional round's cases intended for use when not engaging enemy MBT targets. The cost of the war in Vietnam impacted many weapon systems in the late 1960s. It also highlighted many problems with the 152mm/Shillelagh system deployed with the M551s. The system's reputation was sullied- and missile launching tanks came to be viewed with derision by armored corps officers as technical problems piled up. Full resolution of the issues associated with the Shillelagh were never achieved to a satisfactory level.

The Shillelagh-armed version of the M60 was tested over the course of several years and was ordered in 1971 (at around the same time that the MBT70 was cancelled). The turrets had been approved for production and paid for in 1966 and the hulls the following year, so it is unclear if the M60A2s were assembled from 243 existing stored turrets and hulls in 1971 or built from scratch. The M60A2 was a complex vehicle but it was eventually made to work. The Shillelagh missile, if successfully guided to its target, could defeat any tank of its generation, and the system could fire a range of powerful 152mm low velocity rounds when operating in the gun role. Additionally, the M60A2 suffered from a low rate of fire due to the need to purge the gun after each conventional round or the need to remove an obturator plate after each missile was fired. A standard stowage included 13 missiles and 33 rounds of 152mm ammunition of up to three different types.

Overshadowed by advances in gun development in the mid-1970s and by the success of simpler antitank missile



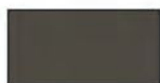
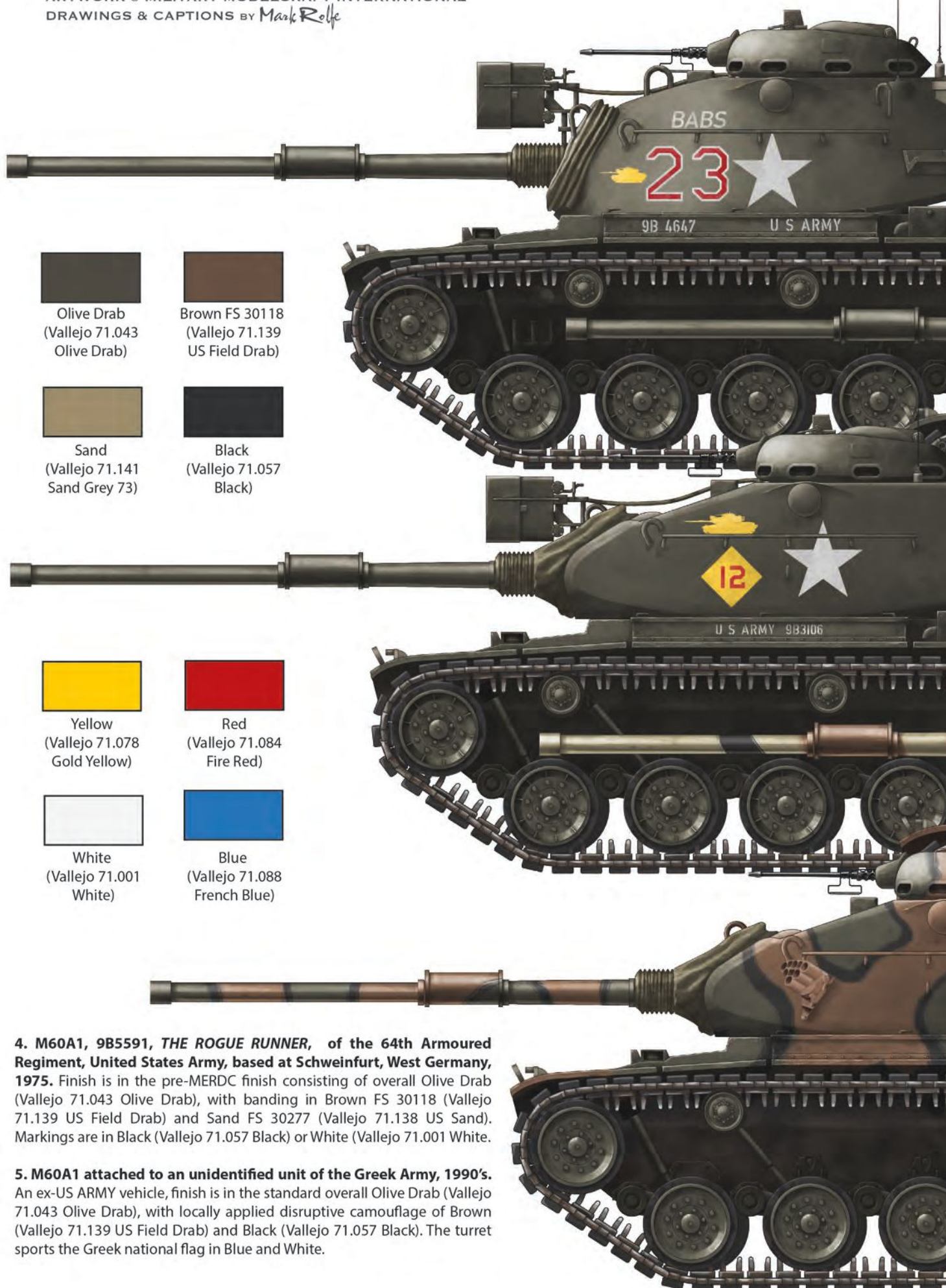
**15** After the M1 Abrams entered service the M60A1 was progressively replaced in West Germany by the M60A3. *(Michael De Bock)*

**16** The M60A1 remained in service in large numbers in US-based Army formations, in the USMC and in the Army National Guard in the 1980s. *(Michael De Bock)*

**17** The large training areas around Fort Riley were heavily used in the mid-1980s to train regular, reserve and Army National Guard armored units. Some of these M60A1s were partly or fully equipped with steel roadwheels. *(Michael De Bock)*







Olive Drab  
(Vallejo 71.043  
Olive Drab)



Brown FS 30118  
(Vallejo 71.139  
US Field Drab)



Sand  
(Vallejo 71.141  
Sand Grey 73)



Black  
(Vallejo 71.057  
Black)



Yellow  
(Vallejo 71.078  
Gold Yellow)



Red  
(Vallejo 71.084  
Fire Red)



White  
(Vallejo 71.001  
White)



Blue  
(Vallejo 71.088  
French Blue)

**4. M60A1, 9B5591, *THE ROGUE RUNNER*, of the 64th Armoured Regiment, United States Army, based at Schweinfurt, West Germany, 1975.** Finish is in the pre-MERDC finish consisting of overall Olive Drab (Vallejo 71.043 Olive Drab), with banding in Brown FS 30118 (Vallejo 71.139 US Field Drab) and Sand FS 30277 (Vallejo 71.138 US Sand). Markings are in Black (Vallejo 71.057 Black) or White (Vallejo 71.001 White).

**5. M60A1 attached to an unidentified unit of the Greek Army, 1990's.** An ex-US ARMY vehicle, finish is in the standard overall Olive Drab (Vallejo 71.043 Olive Drab), with locally applied disruptive camouflage of Brown (Vallejo 71.139 US Field Drab) and Black (Vallejo 71.057 Black). The turret sports the Greek national flag in Blue and White.



**1. M60, 9B4647/'23', BABS, attached to Company B, 3rd Battalion, 64th Armoured Brigade, 3rd Infantry Division (Mechanized), Germany, mid-1960's.** Finish is in overall Olive Drab (Vallejo 71.043 Olive Drab). The vehicle number is in Red (Vallejo 71.084 Fire Red) with a White (Vallejo 71.001 White) outline. The M60 silhouette is in Yellow (Vallejo 71.078 Gold Yellow), with the registration in White.

**2. M60, serial unknown/'31', COUNT, attached to Company C, 3rd Battalion, 64th Armoured Brigade, 3rd Infantry Division (Mechanized), Germany, mid-1960's.** Finish is in overall Olive Drab (Vallejo 71.043 Olive Drab). The vehicle number is in Red (Vallejo 71.084 Fire Red) with a White (Vallejo 71.001 White) outline. Again, the M60 silhouette is in Yellow (Vallejo 71.078 Gold Yellow).

**3. M60A1, 9B3106/'12', of the 3rd Armoured Division, United States Army, 1960's.** Finish is in overall Olive Drab (Vallejo 71.043 Olive Drab). The vehicle number is in Red (Vallejo 71.084 Fire Red) on a Yellow (Vallejo 71.078 Gold Yellow) diamond. The M60 silhouette is also in Yellow. The vehicle registration and US ARMY titles are in White.



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<http://www.acrylicosvallejo.com>







**18** The steel wheels were originally intended for the M48 series but proved interchangeable with the M60 series, which was originally equipped with lighter aluminium wheels. (Michael De Bock)

**19** M60A1s of 1-34 Armor were painted in different versions of the US MERDC scheme intended for woodland and arid terrain. (Michael De Bock)

**20,21** These images from Michael De Bock's collection provide a good visual guide to the modeller for how to weather and stow an M60A1 serving at Ft Riley in the mid-1980s. (Michael De Bock)



systems like the TOW, the M60A2 was withdrawn from service in 1980. It only served in armored regiments for about six years, and it disappeared as soon as the M1 came on line in quantity in 1980. Its crews remember it as a vehicle that absorbed many man hours in maintenance, trouble shooting training and system checks to keep operational. Next to the new M1 Abrams, it might have seemed that the guided missile MBT was a technological dead end. Nearly all of the M60A2s were remanufactured and put to good use after retirement, some becoming bridgelayers, and others becoming M60A3s.

#### **M60A1 RISE**

The M60 and M60A1 were adopted throughout the United States Army's armoured divisions in the early 1960s, and the M48 was supplemented and gradually replaced, except in the USMC and in Army armored units outside of Europe. It saw no action in the Viet Nam conflict, but was instead blooded against some of the best weapons the Soviets had developed in the 1973 Yom Kippur War in Israeli service. The M60A1 underwent a major upgrades from 1975 and 1977 onwards to improve key features, under the acronym **RISE (Reliability Improved Selected Equipment)**. The original RISE program was oriented towards the improvement of the powertrain, introducing the AVDS-1790-2C engine and improvements to the electrical system. The program was expanded in 1977 to improve turret systems, introducing passive night vision sights for the gunner and commander and new passive driving optics for the driver (these tanks being designated M60A1 RISE PASSIVE). The M60A1 RISE PASSIVE also introduced a fording kit to rival those in use in the Leopard 1 and the AMX30, which allowed the M60A1 to perform river crossings completely submerged.

#### **M60A3**

The last production version of the M60 gun tank was introduced in 1978, as the M60A3. This vehicle incorporated fire controls based





**22**



**23**



**24**

**22** Note how the fume extractor is painted sand to better show up the vehicle names. (*Michael De Bock*)

**23** M60A1s of 1-77 Armor training in the 1970s. Note the large turret callsigns. (*US Army*)

**24** A deep fording kit was provided for the M60A1 in

the 1970s, although experiments to test the feasibility of these operations with the M60 had been completed several years previously. (*US Army*)

**25** M60A3s move into position for a river crossing during Exercise Carbine Fortress, part of REFORGER 1982. (*US Army*)



**25**





**26** Another M60A3 moves down a narrow German street during Carbine Fortress '82. (US Army/SSgt. Bob Simons)

**27** M60A3 tanks and M88A1 ARVs move by barge down the Albert Canal as part of REFORGER

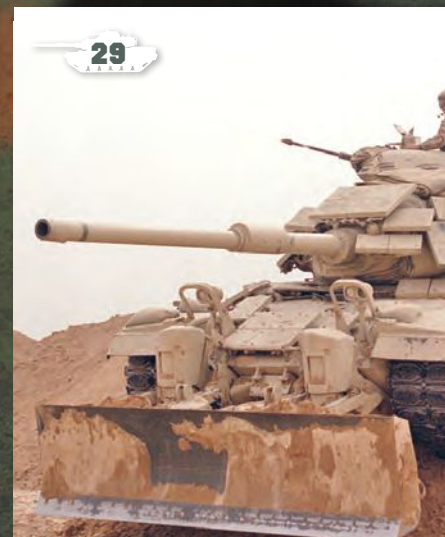
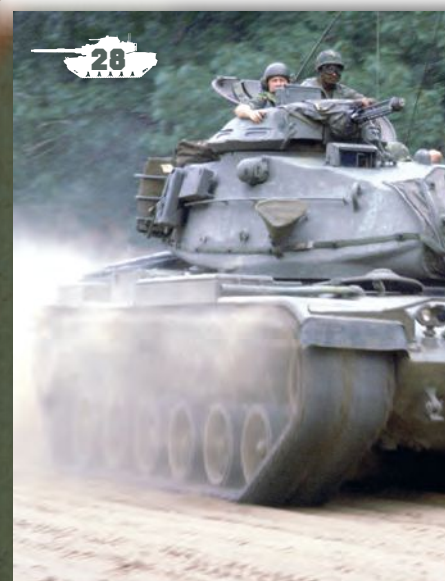
1984. (US Army/Bram de Jong)

**28** An M60A3, fitted with the MILES (Multiple Integrated Laser Engagement System), of 1-108 Armor, Georgia National Guard, during annual exercises at Fort Irwin, CA. (US Army)

on new ballistic computer and a new laser rangefinder. These were linked to a new gun stabiliser. The M60A3 thus brought the basic M60A1 configuration up to date for the 1980s, a decade where the arrival of new tanks like the M1, Leopard II and Challenger introduced advances like Chobham armour, hunter killer fire controls and 120mm main armaments. If the M60A3 was overshadowed by the technological marvel that the M1 represented, it honorably held the line with the M60A1 while enough M1s were built. When the Cold War ended the M60A1 and M60A3 disappeared rapidly from the US inventory. Some 5000 M60A1s were remanufactured as M60A3s by that time and the type was very well regarded by its crews.

#### Conclusion

Over the years some have derided the M60 series because the M68 gun wasn't quite as





powerful as the Chieftain's L11 120mm, or because it wasn't as agile as the Leopard or AMX30. It has been criticized for its high silhouette and for its 51-ton weight in some quarters. It cannot be argued that it proved to be a fine combat vehicle and one that earned its spurs the hard way - on the battlefield. The M60 continues to defy its detractors and is still in service in many countries. Modern upgrades for the venerable M60A1 and M60A3 range from 120mm main armament kits to extensive passive and active armour upgrades, as well as a whole range of improved optics and fire controls in keeping with modern electronic advances. As such, the M60 soldiers on, a remarkable feat of longevity and a tribute to its sound design. The author thanks Joe Cottone, Michael De Bock, Frank Moseley and Raymond Fudge for their help with this article.



**29** In 1991 the USMC employed the M60A1 RISE equipped with Blazer armour in combat during Operation Desert Storm. Note how the commander's cupola remained in use in the American conversion. *(USMC)*

part of the MILES, to an M60 MBT at Fort Knox. *(US Army/Sgt. Kenneth Dill)*

**31** Israeli development of the Magach into the Magach 6 and Magach 7 has altered the type's appearance considerably. The turret has received a massive armour upgrade employing technology developed in

the Merkava programme. *(Israeli Government Press Office)*

**32** Thai Army M60A1s photographed during exercises. The M60 series continues to serve all around the world. *(USMC)*





# ARMOUR IN PROFILE



Leif Robinson examines the world's premier MBT.



## THE ABRAMS: FOUR DECADES OF EXCELLENCE

**A**s the Abrams nears its fourth decade of service, its admirers can take stock its long reign as possibly the world's ultimate battle tank. The United States has built and rebuilt over 9,000 M1 Abrams series main battle tanks since 1979. From futuristic technological marvel when

it was first introduced into service, to the latest M1A2 SEP battle tanks we know today, the Abrams has dominated NATO gunnery contests and the post-Cold War battlefield in a way that no other tank could. It has been modified and updated considerably and remains one of the most

powerful weapons of its kind in service anywhere. The Abrams was born out of the failure of the MBT70 partnership with West Germany, designed from the outset as a weapon system that combined the best of American and foreign technology.

The original M1 Abrams was an advanced and highly mobile Main Battle Tank that incorporated the best features of American fire control and automotive technology. The original M68 gun fitted to the M1 was the same gun carried by the M60 series MBTs that had served the United States Army since 1960 (an American adaption of the British L7 series 105mm gun). In 1984 the M1IP (Improved Performance) was introduced with an up-armoured turret and turret bustle stowage rack (the main external distinguishing feature, although the rack was retrofitted to older

M1s). The more powerful Rheinmetal-licensed 120mm M256A1 smoothbore gun was adopted to arm the M1A1, which appeared in service in 1986. Forty rounds of 120mm ammunition were carried, 34 of them in two vented turret bustle compartments that offered protection by isolating the ammunition in case of penetration. It was with the M1A1 that the US Armored Force inflicted devastating casualties against Iraqi T72s and other Soviet designed MBTs in 1991. A special version of the M1A1 with depleted uranium layers in its Chobham armour was also produced, designated M1A1HA (for **Heavy Armor**). The M1A1 gained a fearsome reputation that reflected its excellent combat performance in Operation Desert Storm.

The improved M1A2 ordered in 1990 included advanced electronics that improved



**1** The prototype XM-1 Abrams underwent extensive field testing before entering service in 1981.

**2** The original M1 Abrams Main Battle tank, armed with the M68 series 105mm gun. The M1 was the first production tank fitted with Chobham

armour and the first western production tank powered solely by a gas turbine engine. Its main armament ammunition stowage was in three sealed and vented compartments, two of which occupied most of the turret bustle. (*General Dynamics/US Army*)



situational awareness, battlefield navigation and communications for the crew and within each Abrams unit. The commander received an independent thermal viewing system ahead of the loader's hatch and a new cupola weapons station. The commander's thermal viewer improved the commander's target acquisition and battlefield observation capability regardless of weather. The gunner's primary sight unit received two-axis stabilization. The new communications system was routed through the M1A2's radio system and essentially functions as a live GPS map network that plots the tank's position and those of its platoon mates. The system also doubles as a real time live command and control system. With this battlefield management system the M1A2 had a clear advantage over most of its contemporaries. The M1A2's basic armour was also improved with depleted uranium layers to match the earlier M1A1HA's level of protection. The longer 120mm L55 smoothbore gun was another option that could have been adopted at the time, but the US Army and USMC have kept the M256A1 L44 gun up to the present time. American ammunition development programmes have not been neglected since the Cold War, allowing the M256A1 to keep abreast of developments in reactive armour and particularly to improve the weapon's performance against 'softer' targets. The **System Enhancement Package (SEP)** introduced for the M1A2 in 1995 was the next stage in the Abrams' evolution. By the early 1990s the Abrams had been adopted by the Marine Corps as well as the Army and maintaining multiple versions of the same vehicle was deemed wasteful. The SEP programme was envisaged to bring all of the M1A1s and M1A2s in the US inventory up to the same M1A2 SEP standard, a massive undertaking that was not fully attainable due to cost. The Army decided instead to upgrade their 600 M1A2s and about 550 M1A1s to M1A2 SEP standard and to overhaul and improve a



**3** Another view of the original M1 Abrams Main Battle tank. (*General Dynamics/US Army*)

**4** A rear view of an M1IP at Fort Riley. The armoured exhaust grilles gave the powerpack a measure of protection from smaller calibre weapons. The M1's

gas turbine's exhausts were hot enough to cause injury at close range and could damage equipment left in proximity for any length of time. (*Michael DeBock*)

**5** A 105mm night shoot by M1s at Fort Riley in 1986. By this time the M1A1 was already in the works. The M256

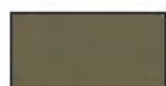
120mm L44 smoothbore gun gave the Abrams hitting power to match its excellent armour. Its barrel was fitted with a muzzle reference system, a fume extractor and a two-part aluminium thermal sleeve to minimise barrel bend. (*Michael DeBock*)





- 1. M1 Abrams, 3rd Battalion, 67th Armoured Regiment, 2nd Armoured Division, based at Fort Hood, Texas, circa 1983.** Overall Forest Green (Vallejo 71.294 Forest Green). All markings are in Black (Vallejo 71.057 Black).
- 2. M1 Abrams, 2nd Battalion, 67th Armoured Regiment, 2nd Armoured Division, based at Fort Hood, Texas, summer 1983.** Overall Forest Green (Vallejo 71.294 Forest Green), with disruptive areas of Red Brown (Vallejo 71.293 US Earth Red) and Sand (Vallejo 71.138 Sand).
- 3. M1 Abrams, 11th Armoured Cavalry, Blue Force, NATO Exercise Reforger '83, Germany, autumn 1983.** Overall Forest Green (Vallejo 71.294 Forest Green), with areas of over-applied mud to confuse opposing forces.
- 4. M1 Abrams, 11th Armoured Cavalry, Blue Force, NATO Exercise Reforger '83, Germany, autumn 1983.** A variation on the scheme given in profile 3, finish in overall Forest Green (Vallejo 71.294 Forest Green), with areas of mud applied in blotches, again to sow confusion within opposing forces.

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Forest Green  
(Vallejo 71.294 Forest Green)



Red Brown  
(Vallejo 71.293 US Earth Red)



Sand  
(Vallejo 71.138 Sand)



Mud



Mud (variation)



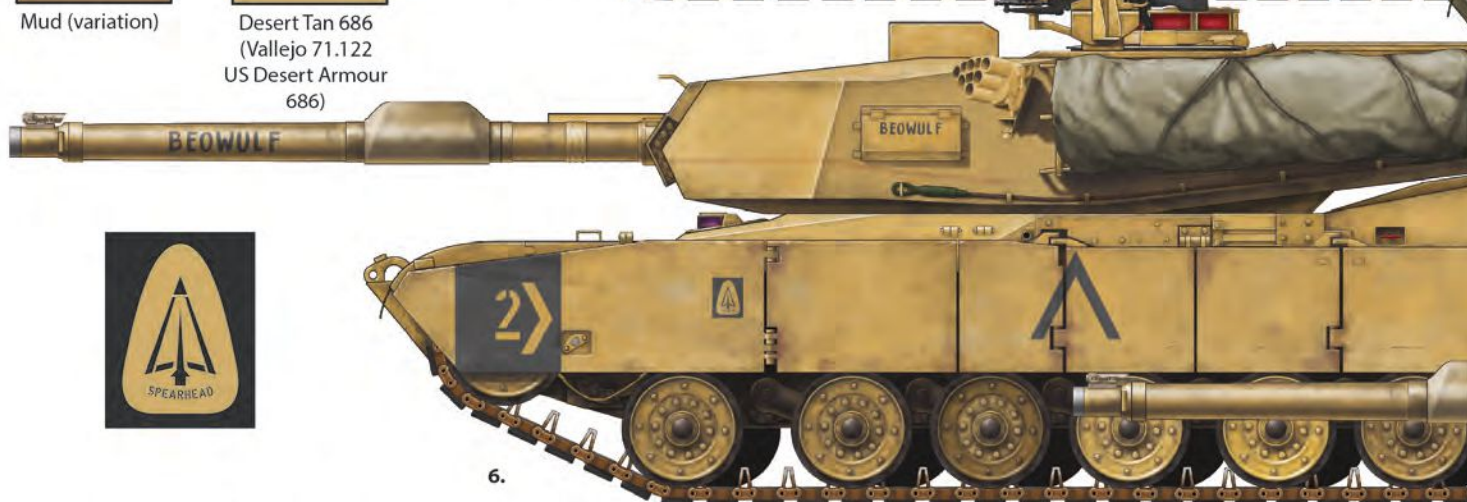
Desert Tan 686  
(Vallejo 71.122 US Desert Armour 686)



2.



4.



6.

- 5. M1 Abrams, attached to Delta Company, 1st Battalion, 64th Armoured Regiment, 3rd Infantry Division, Germany, circa 1983-84.** Overall Forest Green (Vallejo 71.294 Forest Green), with areas of winter white distemper applied to the hull and turret. Note that the tank has only been partially covered. This profile is based on available photographic reference.
- 6. M1A1 Abrams, Beowulf, 2nd Brigade, 3rd Armoured Division, Kuwait, early 1991.** Overall Desert Tan 686 (Vallejo 71.122 US Desert Armour 686). All markings are in Black.
- 7. M1A1 Abrams, VII Corps, Operation Desert Storm, 1990.** Overall Desert Tan 686 (Vallejo 71.122 US Desert Armour 686). All markings are in Black.









**6** One of the victors of the famous Canadian Army Trophy competition in 1987. The M1 was by then a mature design and its amazing performance in the NATO gunnery competition confirmed its reputation. (*Ron Mihalko*)

**7** An M1A1 Abrams main battle tank arrives on a Saudi transport truck during Operation Desert Shield. The M1A1 carries 40 rounds of 120mm ammunition: 6 in the hull, and two racks of 17 each in the turret. The M1A1 had replaced the M1 tank in most US tank units by the early 1990s. (*US Army, Sgt. B. Cumper*)

**8** The secondary armament of the M1 has remained unchanged throughout its service: the commander's M2HB .50cal MG and a coaxial and a pintle-mounted M240 7.62mm MG.

**9** An M1A1 Abrams main battle tank lays a smoke screen during maneuvers just prior to the beginning of Operation Desert Storm. (*US Army*)

**10** An M1A1s from the 13th Marine Expeditionary Unit Tank Platoon photographed during training at 29 Palms, California in 2003. (*U.S. Navy, PH1 T. Banks*)

**11** An M1A1 seen during a joint USMC and Emirati Marines live fire exercise at Al Hamra, United Arab Emirates in December 2009. (*USMC, Cpl. J. Belovarac*)

**12** An M1A1 of the 1st Armored Division seen north of Frankfurt during exercise Ready Crucible in February 2005. (*US Army, R. Bumgardner*)







portion of the remaining M1A1 inventory with less drastic improvements focused at vehicle electronics. The M1A2 SEP version 2 introduced several other new features found necessary in combat in Iraq, including improved side armour, a remote weapons station, improved computer displays and communications equipment, and an improved transmission to deal with the Abrams' increased weight. Some 7,000 older M1A1s are in course of being upgraded more modestly into M1A1D configuration (D is for **digital**) with modernized turret systems and communications.

Separate modular equipment developed for the challenges

of fighting in urban areas in Iraq was developed for the Abrams. The General Dynamics TUSK (Tank Urban Survival Kit) armour upgrade introduced in 2006 was purchased for over 500 M1A2s. The TUSK system can be used in conjunction with a remote weapons station and it can be configured to protect the Abrams crew against different threat levels. In its most basic form it improves survivability on the tanks flanks and rear from antitank missiles and short-range RPG attack. It can also include signal jammers to disrupt IED detonation signals in the tank's proximity. Slat armour fences protect the rear of the hull and turret, reactive armour arrays are fitted

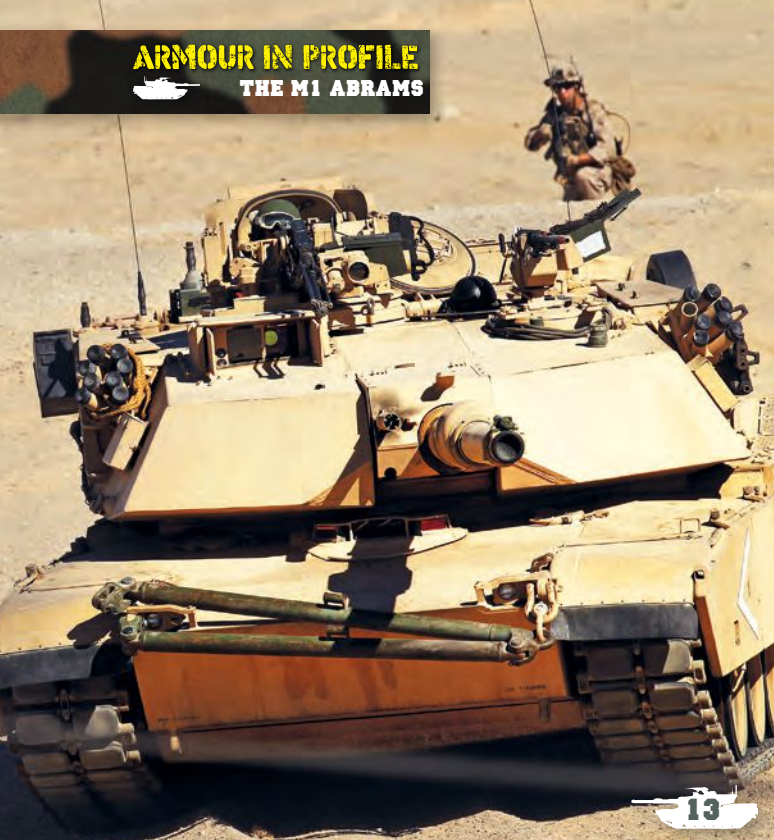


missions in Afghanistan and Iraq. The United States developed a 140mm Abrams Block 3 demonstrator in the mid-1990s to study up-gunning the Abrams, but

rapid target acquisition and hunter/killer fire controls have enabled single M1A1s to knock out multiple adversaries in quick succession in 1991 and again in 2003. The only other







**13** A USMC M1A1 Abrams Tank, manned by a Royal Australian Armoured Corps crew, and scouts from the 1st Tank Battalion, USMC patrol through the streets of Range 200, at Twentynine Palms in the summer of 2013. *(USMC Cpl. W. Johnson)*

**14** Iraqi soldiers from the 9th Iraqi Army Division instructed by American tankers from the 3rd Battalion, 69th Armored Regiment of the 1st Brigade, 3rd Infantry Division in Al Rashid, Iraq, in July 2010. *(US Army PFC G. Silverman)*

**15** Boresighting USMC M1A1s stationed in Helmand Province, Afghanistan in 2011. *(USMC. N. Johnson)*

**16** The TUSK kit was adopted to give the M1A1 and M1A2 improved survivability when fighting in an urban environment. This vehicle was photographed in Iraq in 2008. *(US Navy)*

**17** Operation Ready Crucible in 2005 was one of the largest US exercises in Germany since the end of the Cold War. The M1A1 seen here is driving through a small town north of Frankfurt. *(US Army, R. Bumgardner)*

**18** An M1A2 SEP2 of the 2nd Battalion, 12th Cavalry Regiment, 1st Brigade Combat Team, 1st Cavalry Division during a calibration shoot on the Grafenwöhr Training Area in late 2014. Note that this vehicle is fitted with a mine plough. *(US Army Capt. J. Farmer)*





18

**19** In response to a resurgent Russia, the US Army and USMC's Abrams have deployed numerous times in recent years to exercise with new NATO members. One of the most important of these is Poland, which has hosted large multinational maneuvers including American forces.

These men and tanks are from the 2nd Battalion, 8th Cavalry Regiment, 1st Brigade Combat Team, 1st Cavalry Division, seen during Operation Atlantic Resolve in Poland in October 2014. *(US Army B. Ames)*

**20** With the strategic mobility represented by America's extensive

logistics capabilities, weapons like the Abrams can and will be sent across the world to support American soldiers in their missions quickly and effectively for years to come. The M1 Abrams series have proven to be one of most successful tank designs ever built and they will remain potent weapons for

many years to come. *(US Army R. Tatum)*

**21** The same exercise included the deployment of US armoured forces in Latvia, a projection of NATO power that would have been unthinkable twenty years ago. *(US Army)*



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MBTs with similar firepower and armour protection were operated by America's allies. The United States also benefitted from having a large number of Abrams in the national inventory, unlike America's NATO allies. The Abrams thus enjoys a rare combination of quality and quantity unmatched elsewhere in the world.

In recent years the appearance of the new Russian T14 *Armata* has caused some alarm in NATO circles, but it remains an unknown quantity. While the T14's innovative layout and advanced technology have seemingly levelled the playing field in some respects, the new Russian tank remains untested in combat, and it



23



24

**22** A USMC M1A1 drives along Highway 27 near An Nu'maniyah, Iraq, during Operation Iraqi Freedom. (USMC/Sgt. Paul L. Anstine)

**23** Another USMC M1A1, this fitted with a mine plough, photographed on the same road during the initial stages of the war in Iraq. (USMC/GYSgt. Erik S. Hansen)

**24** An M1A1, fitted with a mine clearing attachment, from 3rd Cavalry Regiment during Joint Readiness training at Fort Polk, LA, in 1999. (U.S. Army/PFC Michael Karp)

**25** A destroyed USMC M1A1 of Bravo Company, 2nd Tank Battalion, near Sayyid Abd, Iraq, during Operation Iraqi Freedom. (USMC/MSgt. Howard J. Farrell)

**26** A joint U.S. and Korean crew aboard an M1A1 during Exercise Foal Eagle, held in South Korea, in 2002. (U.S. Navy/Stacy Young)

**27** Members of 3rd Platoon, Charlie Company, 3-69 Armor, 3rd Infantry Division perform maintenance on their M1A2 tank in Iraq, 2005. (U.S. Army/Maj. Anthony Buchanan)



25



may yet need time to develop into an operational weapon system. Other challenges from the RPG29 and the *Kornet* ATGM to the supremacy of NATO's MBTs, including the Abrams - remind us that the gun-armour race is not the only factor to be considered. The next step forward for the Abrams programme will be interesting to see although details are naturally scarce. In the meantime, the inevitable comparisons and speculation on the relative merits of the M1A1 and M1A2 versus those of the T14 are only to be expected. The United States will no doubt continue its successful development of the M1 series to meet- and overcome, these challenges. 🇺🇸



26



**28** A USMC M1A1 moves through the surf towards a beach during a landing exercise. The tank is equipped with two air intake towers on the left side of the hull, towards the back of the turret, and an exhaust tower on the rear of the hull. (NARA)



27



28



# ARMOUR IN PROFILE

David Grummitt looks at how the United States' Main Battle Tank is meeting the challenges of today.



*(U.S. Army/Spc. Andrew McNeil)*

## THE M1 ABRAMS TODAY

In the last few years, and especially since the war in Ukraine in 2014-15, the United States warfighting strategy has moved away from counter-insurgency and hybrid warfare to facing peer or near-peer competitors on the battlefield. This move away from Low Intensity Combat (LIC) situations has necessitated a renewed emphasis on Combined Arms Manoeuvre (CAM) and the type of heavy weapons platforms,

especially the Main Battle Tank, that were typical of the Cold War period. Central to this doctrine, of course, is the M1 Abrams MBT, alongside the M2/M3 Bradley and the M109A6 self-propelled howitzer. Here, we look at the M1 Abrams in service today, both with the U.S. Army and USMC, as well as with other nations.

**From Baghdad to the Baltic**  
The M1 Abrams played a crucial part in the Coalition's victory

over the forces of Saddam Hussein as part of Operation Iraqi Freedom in 2003, just as it had done in the First Gulf War twelve years previously. As part of the doctrine of 'Shock and Awe' Abrams from both the U.S. Army and the USMC were at the forefront of the invasion which began on 20 March. On 9 April Baghdad fell after the famous 'Thunder Run', led by Abrams of 64th Armor Regiment, 3rd Infantry Division. The Abrams

proved itself a formidable opponent and a combination of poor training, equipment and tactical employment ensured the Iraqi regular army and Republican Guard was no match for the Coalition armour. Soon after, however, the nature of the conflict changed. Although President Bush had famously proclaimed 'Mission Accomplished' on 1 May 2003, insurgent attacks upon the Coalition forces began



to increase leading to the bloody two battles of Fallujah in April and November 2004. By March 2005 some eighty Abrams had been disabled by Iraqi regular forces and insurgents, the vast majority by the latter employing IEDs (Improvised Explosive Devices).

Heavy armour played a crucial role in the U.S. counter-insurgency operation. The Abrams provided both a heavily protected platform, minimising casualties, and an effective means of delivering concentrated, precision firepower on the insurgents. Two developments to the Abrams during this period demonstrate the tank's successful deployment in LIC. The new M1028 120 mm anti-personnel canister cartridge contained over a thousand 38-inch (9.5 mm) tungsten balls, producing a shotgun effect lethal out to 600m. The round was employed both an anti-infantry weapon, but also to destroy concrete buildings. The second innovation was the TUSK (**T**ank **U**rban **S**urvival **K**it), a series of field-installed Reactive Armour tiles, passive armour belly protection, and (initially at least) slat armour designed to counter IEDs, RPGs and other insurgent tactics. The kit also included enhanced protection for the commander and loader, allowing them to observe the battlefield behind armoured glass and a second coaxial 12.7mm M2HB machine gun mounted directly above the main gun and fired remotely. By 2008, 550 TUSK packages had been delivered and they proved successful in Iraq.

The experience of war in Iraq and Afghanistan led to a debate within the U.S. military over the future of the Main Battle



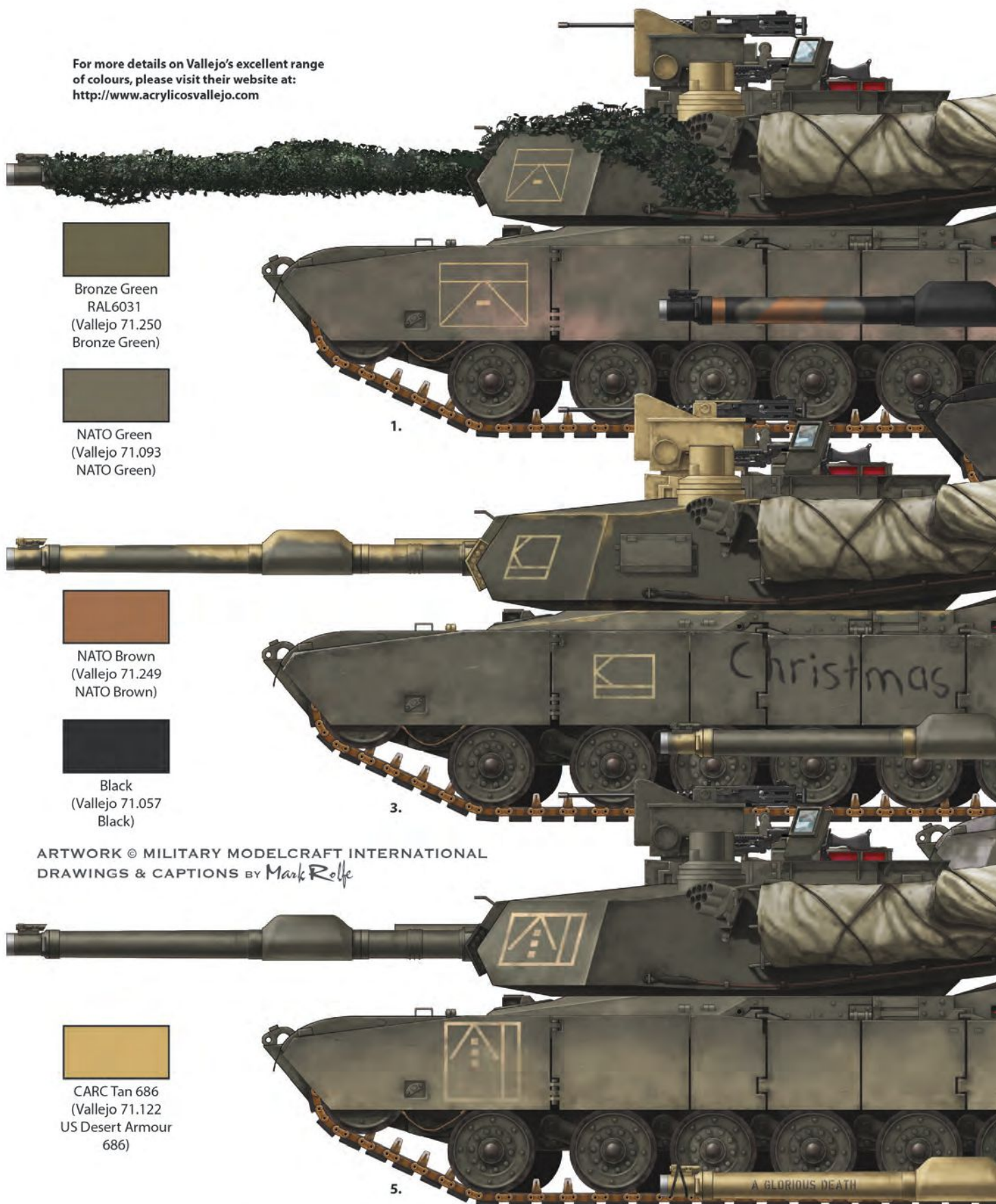
**1** A heavily weathered M1A1 of 4th Cavalry Regiment in Iraq, 2004. (U.S. Army).

**2** An M1A2 SEP V2 of 3rd Battalion, 69th Armor Regiment, 1st ABCT, 3rd Infantry Division taking part in Operation Iron Sword, November 2015, in Lithuania. This was part of Operation Atlantic Resolve. Note the RAL6031 paint covering the CARC Tan and the M88A2 ARV following behind. (U.S. Army/Staff Sgt. Michael Behlin)

**3** Another M1A2 SEP V2 during a joint combined arms live-fire exercise near Camp Buehring, Kuwait December 2016. (U.S. Army/Sgt. Aaron Ellerman)



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**3. M1A2 SEPv2 Abrams, 1st Battalion, 18th Infantry Regiment, 2nd Armoured Brigade Combat Team, 1st Infantry Division, during training at the Smardan Training Area, Romania, December 2017.** Overall Bronze Green RAL6031 (Vallejo 71.250 Bronze Green). Areas of the vehicle have been left in CARC Tan 686 (Vallejo 71.122 US Desert Armour 686), along with the vehicle markings. Note the graffiti.

**4. M1A2 SEPv2, C Company, 1st Battalion, 18th Infantry Regiment, 2nd Armoured Brigade Combat Team, 1st Infantry Division, during Exercise Justice Eagle, Smardan, Romania, April 2018.** Overall Bronze Green RAL6031 (Vallejo 71.250 Bronze Green), with disruptive camouflage in White (Vallejo 71.001).

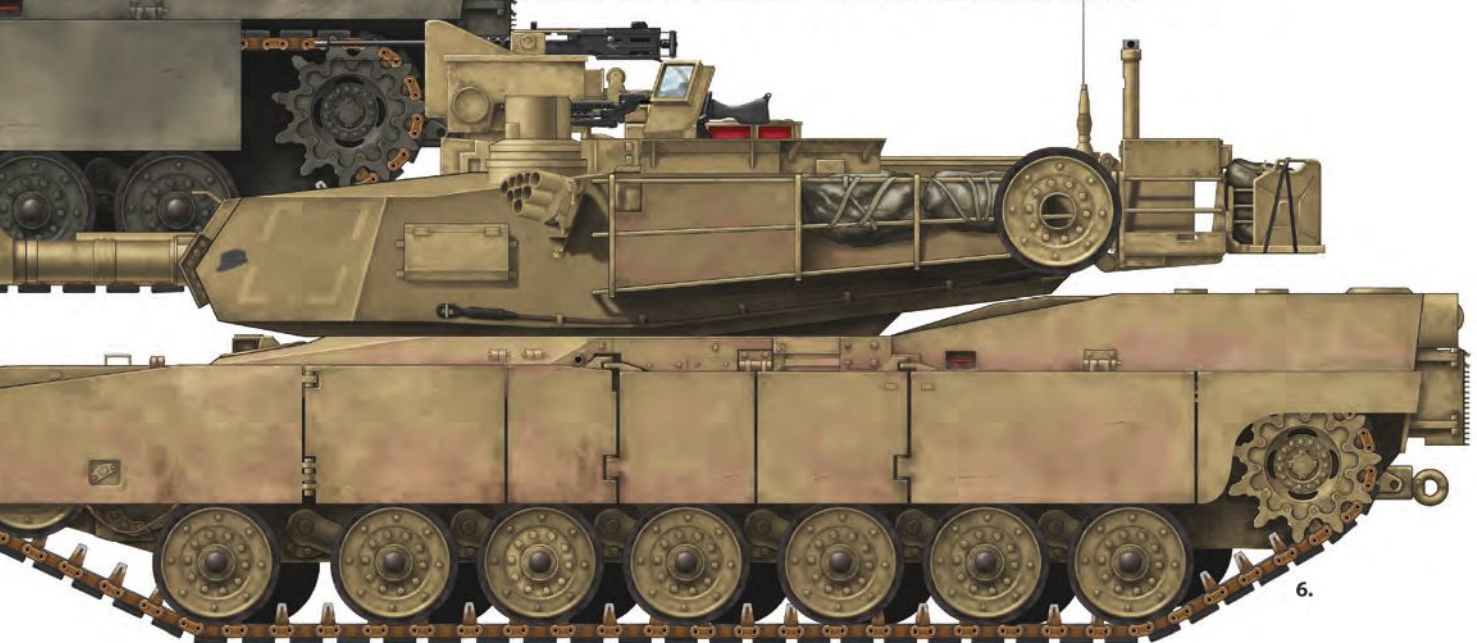
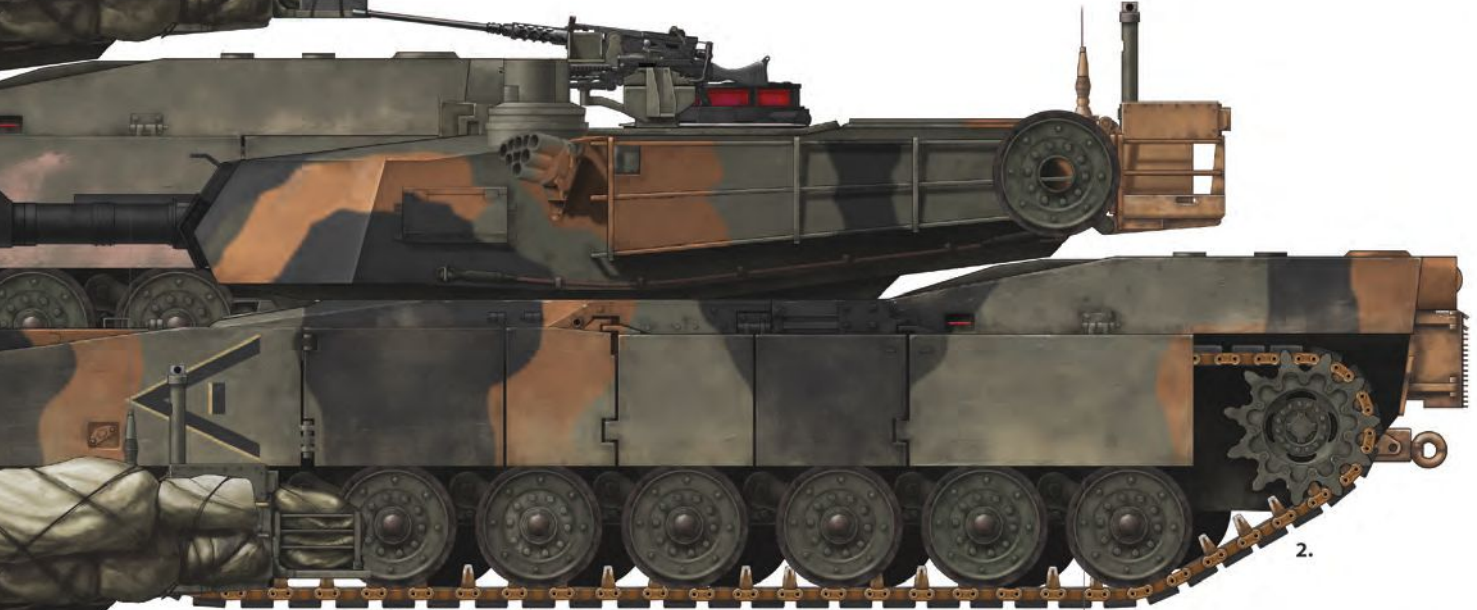
**5. M1A2 SEPv2 Abrams, 2nd Armoured Brigade Combat Team, 1st Infantry Division, during Live Fire Exercise Combined Resolve X, Grafenwoehr, Germany, April 2018.** Overall Bronze Green RAL6031 (Vallejo 71.250 Bronze Green). All markings are left in CARC Tan 686 (Vallejo 71.122 US Desert Armour 686).

**6. M1A2 Abrams, A Glorious Death, Karlikie Range, Zagan, Poland, January 2017.** Overall CARC Tan 686 (Vallejo 71.122 US Desert Armour 686). All markings are in Black.



**1. M1A2 SEPv2 Abrams, 1st Platoon, A company, 2nd Armoured Brigade, 1st Infantry Division, Exercise *Allied Spirit*, Hohenfels Training Area, Germany 2017.** Overall Bronze Green RAL6031 (Vallejo 71.250 Bronze Green) with components in CARC Tan 686 (Vallejo 71.122 US Desert Armour 686). All markings are in CARC Tan 686 (Vallejo 71.122 US Desert Armour 686).

**2. M1A1 Abrams, 1st Platoon, B Company, 2nd Tank Battalion, Marine Corps Base Camp Lejeune, North Carolina, 2016.** NATO Green (Vallejo 71.093 NATO Green), NATO Black (Vallejo 71.057 Black) and NATO Brown (Vallejo 71.249 NATO Brown). Markings are in Black and CARC Tan 686 (Vallejo 71.122 US Desert Armour 686).







Tank. In a world of budgetary constraints following the 2009 Financial Crisis and where it was believed in some circles that the fundamental nature of warfare had changed, a school of thought argued that the MBT was redundant and that wars in the future would be waged through UAVs (Unmanned Aerial Vehicles), long-range ballistic ordnance, special forces and an increased use of electronic warfare. The last remaining U.S. armoured units were withdrawn from Germany in 2013. The Abrams was a relic of the Cold War and production should be scaled down. Indeed, it was planned to end production at the Lima Army Tank Factory from 2013 to 2016.

The Ukraine crisis of 2014 and the Russian annexation of Crimea changed the geopolitical situation and forced the U.S. to reassess its warfighting capabilities. Concern among the United States' northern and central European NATO partners led to Operation Atlantic Resolve, a U.S.-led NATO effort to assure Russia's nearest neighbours, and particularly the Baltic States, of NATO's continuing commitment to their defence. From 2015, as part of the European Reassurance Initiative, until its redeployment to the U.S. in September 2017, 3rd Armored Brigade Combat Team, 4th Infantry Division, with 87 M1A2 Abrams, stationed in Germany demonstrated the United States' commitment to European security and took part in NATO exercises from Estonia to Bulgaria. These exercises marked a renewed emphasis on CAM and tactical co-operation between NATO

**4** A heavily camouflaged M1A2 SEP V2 of 1st Battalion, 98th Cavalry Regiment, 155th ABCT. This tank from the Mississippi National Guard was photographed at the National Training Center, Fort Irwin, California in May 2017 (U.S. Army/Staff Sgt. Shane Hamann)

**5** Boresighting M1A2 SEP V2 tanks of 116th ABCT, another National Guard unit, at the Orchard Training Center, Boise, Idaho. (U.S. Army/Maj. Wayne (Chris) Clyne)

**6** M1A2s of 1st Battalion, 68th Armor Regiment, 3rd ABCT, 4th Infantry Division at the Karlikie Range in Zagan, Poland, January 2017. Note that this SEP V2 does not have the CROWS II installed. (U.S. Army/Staff Sgt. Corinna Baltos)



partners as part of a wider reorientation of the mission of the U.S. armoured force.

### The M1 Abrams in Service Today

The U.S. Army: The US army today operates two variants of the M1 Abrams. The M1A2 SEP V2 is the standard MBT of the regular U.S. Army and one currently deployed with Armored Brigade Combat Teams in the United States, Germany and South Korea. The SEP (Systems Enhancement Package) V2 has a number of systems upgrades over the M1A2 SEPs that saw service in Iraq, but the most notable external difference is the XM153 CROWS II (Common Remote Operated Weapons System) for the commanders' M2HB MG. The National Guard armoured battalions also operate the M1A1 SA (Situational Awareness). These refurbished M1A1s have the same basic upgrades as the earlier M1A1 AIM (Abrams Integrated Management), which included the 'Blue Force Tracker' (for digitally tracking friendly forces), power train improvements and 'Heavy Armour' (steel-encased depleted uranium), but also have a new laser rangefinder, gunner's site and SCWS (Stabilized Commander's Weapon Station).

The U.S. Army's Abrams are deployed across ten Armored Brigade Combat Teams (ABCT), with a further five National Guard ABCTs. Each ABCT has a nominal strength of 90 tanks and contain two armoured battalions (two tank companies and a mechanized infantry company) and two mechanized infantry battalions (one tank company and two mechanized infantry companies). In October 2015 the U.S. Army unveiled its M1A2 SEP V3 tank. Most of the changes are internal and electronic, although the V3 will include a new low profile CROWS and a small exhaust for the generator which powers the fighting compartment without running the main engine. The first four tanks were accepted into service in October last year and it is envisaged that it will replace the SEP V2 by 2020. There can be little doubt that the latest Abrams iteration



**7** Tanks of the same unit take up firing positions during a combined arms live-fire exercise at the 7th Army Training Command's Grafenwoehr Training Area in Germany, July 2017. (U.S. Army/Gertrud Zach)

**8** Soldiers assigned to the same unit prepare a M1A2 SEP V2 Abrams to be off loaded from a rail car in Parsberg, Germany January 2018 following their return from the Smârdan Training Area in Romania. (U.S. Army/Pfc. Shelton)

**9** 2nd ABCT returned to Smârdan in April 2018 for 'Justice Eagle', a bilateral live-fire exercise with the Romanian 282nd Mechanized Infantry Brigade. Note the faded 'Tiger Stripes' whitewash applied over the Bronze Green finish. (U.S. Army/Staff Sgt. Matthew Keeler)







**10** Soldiers from 1st Battalion, 18th Infantry Regiment, 2nd ABCT, 1st Infantry Division, dismount an M1A2 SEP V2 Abrams tank during training in December 2017 at Smârdan Training Area, Romania. (U.S. Army/Pfc. Shelton Smith)

**11** 2nd ABCT returned to Smârdan in April this year for 'Justice Eagle', a bilateral live-fire exercise with the Romanian 282nd Mechanized Infantry Brigade. Note the faded 'Tiger Stripes' whitewash applied over the Bronze Green finish. (U.S. Army/Staff Sgt. Matthew Keeler)

**12** A M1A2 SEP V2 of, 1st Battalion, 63rd Armor Regiment, 2nd ABCT, 1st Infantry Division during the 'Combined Resolve X' live-fire exercise on 19 April 2018 at Grafenwoehr, Germany. (U.S. Army/Spc. Dustin D. Biven)



is designed to counter new Russian platforms such as the T-14 *Armata*. As Major General David Bassett, executive officer for Ground Combat Systems, remarked, "These vehicles are not just about assuring our allies, or deterring or coercing potential adversaries, they are about compelling our enemies and winning the multi-domain battle."

United States Marine Corps: the USMC currently has some 120 M1A1s in service across its three (one a reserve) tank battalions. The role of the Marine Corps' Abrams is to close with and destroy the enemy using expeditionary armour-protected firepower, shock effect, and manoeuvre in support of the MAGTF (Marine Air-Ground Task Forces) across the range of military operations. The two active battalions currently serve as part of the I and II Marine Expeditionary Forces, based at Camp Pendleton, CA, and Camp Lejeune, NC, respectively.

#### The M1 in Foreign Service

Currently, the M1 Abrams serves in the armed forces of six other nations: Australia, Egypt, Iraq, Kuwait, Morocco and Saudi Arabia.

**Australia:** in 2006 Australia bought 59 M1A1 AIM tanks (without the depleted uranium armour) to replace its Leopard AS1 fleet. There is close cooperation between the Australian and U.S. armoured units and a team from Australia (as well as one from Kuwait) competed against American tank crews in the 2018 annual Sullivan Cup. The Australian government has approved an upgrade to its Abrams fleet to M1A2 SEP V2 standard, which may also involve an expansion.

**Egypt:** Egypt has assembled M1A1 tanks in Egypt since 1988 and by 2010 had completed over 1,000 vehicles. U.S. cooperation was withdrawn following the military coup of 2013 but restored two years later and the Egyptian Abrams fleet is projected to reach 1,130. **Iraq:** in 2011 the United States delivered 146 M1A1 SA tanks to Iraq with a view to further deliveries in subsequent years. In 2014 the Iraqi Abrams were deployed against ISIS with disastrous results: within three



months roughly a third had been damaged, captured or destroyed by the militants. By the end of the year only about 40 Abrams remained serviceable with the Iraqi army. Several of the captured tanks were employed by ISIS and also found their way into the hands of other militant groups in Iraq and Syria and at least has been seen operating under the flag of Hizbollah in Syria. The United States has refused to supply further tanks to Iraq and the Iraqi army has recently taken delivery of T-90S tanks from Russia. In the future Iraq plans to operate two armoured brigades, one equipped with Abrams, the other with T-90s!

**Kuwait:** in 1993, in the wake of the First Gulf War, Kuwait purchased 218 M1A2s which remain in service today.

**Morocco:** in 2015 Morocco ordered 222 M1A1s refurbished to SA standard. The first delivery took place in July 2016 with a further one in April this year. The latter caused something of a stir when photos of a train carrying the tanks from the Lima Tank Factory attracted the attention of conspiracy theorists on Social Media!

**Saudi Arabia:** the Saudis purchased 315 M1A2s in 1993. In 2008, at a cost of almost \$3 billion, the fleet was upgraded to M1A2S (basically SEP specifications without the depleted uranium armour). The



**13** Abrams tanks of Alpha Company, 1st Battalion, 63rd Armor Regiment, 2nd ABCT, 1st Infantry Division perform a strategic convoy maneuver during 'Combined Resolve X' at the Hohenfels Training Area on 2 May 2018. This was the first brigade-sized road march by U.S. forces that has taken place in Germany since the end of the Cold War (*U.S. Army photo by Spc. Andrew McNeil*)

**14** A USMC M1A1 from 1st Tank Battalion, 1st Marine Division during Exercise 'Gold Eagle' aboard Marine Corps Air Ground Combat Center Twentynine Palms, California in June 2013. The exercise was a combat arms reciprocal exchange programme which allows U.S. and Australian forces to share knowledge and improve interoperability. (*USMC/Lance Cpl. Jason Morrison*)

**18** An M1A1 with mine plow attachment conducts fire and maneuver training operations with 2nd Tank Battalion, 2nd Marine Division, aboard Fort Stewart, Georgia in February this year. (*USMC/Cpl. Alexander Sturdivant*)





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Saudi M1s have seen action in Yemen against the Houthi rebels, where at least twenty have been lost to enemy action since 2015, mainly to ATGMs (anti-tank guided missiles).

#### The Future

As the experience of armoured warfare in the Syrian conflict, in Israel's recent operations in the Gaza Strip and during the second Lebanon War (2006), and in Saudi Arabia's war in Yemen has shown, the greatest threat to modern MBTs is the ATGM. In February this year the U.S. Army announced it had purchased the Trophy Active Protection System (as fitted to the Israeli Merkava Mk. 4M). 261 units have been purchased, to be fitted in 2019, enough to equip three ABCTs. This is further evidence of the United States' reorientation towards peer-on-peer conflict. In the longer term the upgrade to SEP V3 standard has been approved and beyond there the M1A3 concept is still live. Whatever happens, the U.S. Army expects the M1 Abrams to serve for another two decades at least.

**15** A USMC M1A1 from 1st Tank Battalion, 1st Marine Division during Exercise 'Gold Eagle' aboard Marine Corps Air Ground Combat Center Twentynine Palms, California in June 2013. The exercise was a combat arms reciprocal exchange programme which allows U.S. and Australian forces to share knowledge and improve interoperability. (USMC/Lance Cpl. Jason Morrison)

**16** An Egyptian army M1A1 Abrams tank placed near Tahrir Square during the 2011 Egyptian protests. (Wikimedia/Sherif9282)

**17** Marines with Bridge Company, 8th Engineer Support Battalion, roll an M1A1 off of a seven-bay raft system after being transported across New River during a water-crossing operation at Camp Lejeune in February 2016. (USMC)

**18** An M1A1 of the Tank Platoon, Fox Company, Battalion Landing Team, 2nd Battalion, 6th Marine Regiment, 26th Marine Expeditionary Unit (MEU), conducting live-fire training. The 26th MEU trains to sustain expeditionary readiness across a range of critical capabilities both afloat and ashore in order to be prepared to respond to crisis in the U.S. 5th Fleet Area of Operations (the Persian Gulf, Red Sea, Arabian Sea, and parts of the Indian Ocean). (USMC/Staff Sgt. Dengrier M. Baez)

**19** Another M1A1 of the same unit photographed aboard Fort Stewart. Note the USMC-pattern smoke launchers and the SCWS. (U.S. Marine Corps)





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**20** Marines with Tank Platoon, 1st Battalion, 4th Marines, 11th Marine Expeditionary Unit, drive an M1A1 to a forward operating base during Exercise 'Alligator Dagger' at Arta Beach, Djibouti in December 2016. (*USMC/Robert B Brown Jr*)

**21** A M1A2 SEP V2 of 2-7 Infantry Regiment, 1st ABCT, 3rd Infantry Division, returns from a successful engagement during a live-fire training exercise, at the Central Training Area near Tapa, Estonia in 2016. (*U.S. Army/Sgt. 1st Class Joshua S. Brandenburg*)

**22** An M1A2 SEP V2 of 3-69 Armor Regiment, 1st ABCT, 3rd Infantry Division, at the Drawsko Pomorskie Training Area, Poland, during Exercise Anakonda in June 2016. (*U.S. Army/Sgt. 1st Class Whitney Hughes*)







**23** M1A2 SEP V2s of 2-5 Cavalry Regiment, 1st ABCT, 1st Cavalry Division, zero their 120mm guns during Atlantic Resolve at Zagan, Poland, 2 June 2018. (U.S. Army/Eugen Warkentin)

**24** Abrams of the same unit perform a Live Fire Accuracy Screening Test (LFAST) prior to live-fire gunnery exercises as part of Operation Atlantic Resolve during the summer of 2018. (U.S. Army/Maj. Carson Petry)







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**25-26** USMC M1A1s attached to Tank Platoon, Fox Company, Battalion Landing Team, 2-6 Marine Regiment, 26th Marine Expeditionary Unit during exercise Baltic Operations (BALTOPS) in Ustka, Poland in June 2018. BALTOPS is

the premier annual maritime-focused exercise in the Baltic region and one of the largest exercises in Northern Europe enhancing flexibility and interoperability among allied and partner nations. (USMC/Staff Sgt. Dengrier M. Baez)





# ARMOUR IN PROFILE



David Grummitt examines the long-serving M109 Self-Propelled Howitzer.



## THE KING OF BATTLE

It has been a truism since at least the days of the Prussian king Frederick the Great that artillery is the 'King of Battle'. Countless commanders from Napoleon to McArthur have credited the field artillery with both their victories and their survival. The importance of artillery is unquestioned still on the modern battlefield and no weapons system exemplifies that better than the US Army's 155mm M109 Self-Propelled Howitzer.

### Development and Early History

Self-propelled artillery had played an important role in the

Allied victory in World War II and vehicles such as the 105mm M7 Priest and 155mm M12 and M40, all based on the Sherman chassis, had featured among the US forces that fought in north-western Europe during the last year of the War. The M40 served in the Korean War alongside the M37 and M41 (mounting the 105mm and 155mm howitzers respectively and based on the M24 Chaffee light tank chassis), but two replacement vehicles, based on the chassis of the M41 light tank, were in development by 1950. These vehicles, the M52 (105mm) and M44 (155mm) entered service in 1952, but both proved unsatisfactory. Work was soon underway to develop a new generation of fully enclosed self-propelled howitzers that could meet the challenges of the envisaged nuclear

battlefield of the Cold War. Moreover, the development of effective artillery-location radar during the 1950s made counter-battery fire a very real threat and necessitated a much enhanced level of crew protection than that offered by the open-topped M44 and M52.

In 1959 the first prototypes of the T195 110mm and T196 155mm HSP (**Howitzer Self-Propelled**) enter testing. Problems with the engine and drive train delayed production, but eventually, in June 1963, they were accepted into service as the M108 and M109. Production of the former was short-lived – only 355 were built in 1963 – as the Army required a larger gun. The M109 mounted the 23 calibre 155mm M126 howitzer and carried 28 rounds with a maximum range of 14,600 metres. Between

1963 and 1969 2,111 M109s were built for the US Army and Marine Corps, with a further 1,675 units built for export.

The M109 had its baptism of fire in the Vietnam War. Initially no armoured or mechanised units were deployed in theatre and commanders relied either on heavy, long-range artillery (such as the 203mm M110) or lighter towed pieces. By 1966, however, the utility of the M109 (and M108) was clear. Deployed in forward firebases, defended with earth works and sandbags, the M109 proved itself well-suited to supporting the infantry. Its traversable turret and M2HB .50cal machine gun also made it capable of defending itself against infantry attacks. By 1969, however, the M109s were being withdrawn and two years later the last battery left

**1** An M109A1 moves into position during Exercise Carbine Fortress, part of REFORGER 1982. (U.S. Army/SFC McBride)





- 2** An M109A1 passes through the town of Schlitz-Willofs during Exercise Autumn Forge, part of REFORGER 1983. Note the typically colourful Mobility Equipment Research and Development Center (MERDC) camouflage. (*U.S. Army*)
- 3** An M109A2 of 1-41 Field Artillery at Range 6 at Fort Carson prior to its deployment to support the United Nations' intervention in Somalia, UNOSOM II, in 1993. (*U.S. Army/SPC Gary A. Bryant*)
- 4** An M109A2 of A Battery, 4-29 Field Artillery outside Camp Steel Castle, Bosnia, as part of Operation Joint Endeavour in April 1996. (*U.S. Army/SPC Glenn W. Suggs*)



Vietnam. The Vietnam War had confirmed the basic soundness of the M109 design, but it had also revealed shortcomings in the M126 howitzer and its ammunition when compared to state-of-the-art Soviet designs such as the M46 130mm gun.

### Production Variants

The next four decades would witness a constant programme of measures to update and improve the performance of the M109, its gun and ammunition, alongside, ultimately futile, attempts to design and produce a successor vehicle. The need for greater range had long been apparent and in 1971 the M109A1 entered service. This was armed with the 39 calibre M185 gun which increased the maximum range to 18,100 metres. Other changes necessitated by the increase in firepower included a strengthening of the torsion bar suspension and a new travel lock fitted to the front of the vehicle.

The conversion of M109s to A1 standard continued until 1981, but in the meantime a 'Mid-Life Improvement' program was instituted resulting in the M109A2 being adopted as for production in 1975. A new cannon mount, counterbalanced travel lock, and an improved engine accompanied a new turret bustle stowage arrangement which increased capacity from 28 to 26 rounds. Those M109A1s rebuilt to A2 standard were known as M109A3. The M109A2 eventually entered service in 1980 and 823 new vehicles were built between 1976 and 1985.

Throughout the 1970s and 80s much time, money and effort was spent in developing new forms of artillery round for the M109 series. These included rocket-assisted rounds, various types of sub-munitions and mines, and 'special' rounds. This latter category included chemical weapons (which remained in the US arsenal until 1997) and the W48 nuclear warhead, a simple plutonium-based weapon which delivered a yield equivalent to 72 tons of TNT. Some 3,000 of these tactical nuclear weapons were deployed before they were withdrawn from frontline service with



the end of the Cold War.

The 1980s saw further refinements to the M109 design. The M109A4 introduced enhanced NBC (**N**uclear, **B**iological and **C**hemical) protection, but its deployment was limited to reserve and National Guard units. More significantly the Army launched the 'Howitzer Improvement Plan' (HIP) to develop a new M109, alongside the abortive attempts to design and develop a completely new self-propelled howitzer.

### The Paladin

The HIP resulted in the definitive model of the M109, the M109A6 Paladin. Beginning in 1985 various new guns were trialled and tested with the M109, eventually resulting in the adoption of the 39 calibre M284 cannon in a new mount. The M284 has a maximum range of 22,000 metres with normal munitions and 30,000 metres with rocket-assisted projectiles. Those M109A2/A3s fitted with the new gun and mount were designated M109A5, but the Paladin proper had much more extensive modifications. The Paladin has a redesigned, larger turret incorporating new navigation systems, sensors and a digital communications system. The improvement in rates of fire and accuracy are startling: the Paladin can deploy from the march and be ready to fire within thirty seconds. The Paladin is deployed today in field artillery regiments as part of the Armoured Brigade Combat Team (ABCT). An ABCT currently fields sixteen M109A6s in two batteries and they are deployed in Poland and Germany as part of US Army Europe, as well as on the Korean Peninsula.

The ultimate version of the M109, the M109A7, entered low-level production in 2014. The M109A7 is the result of the Paladin Integrated Management Program. The new variant sports an entirely new chassis and drive train, engine, suspension and steering system, utilising components from the Bradley Fighting Vehicle family. It also has an enhanced 600-volt on-board power system designed to service the emerging



**5** An M109A2 raises a cloud of dust as it leaves its firing position on Range 141 at Fort Carson, CO, in June 1999. (U.S. Army/Michael Knapik)

**6** A well-stowed M109A6 travels along an Iraqi highway towards the Euphrates River during Operation Iraqi Freedom. (USMC/L. Cpl. Andrew P. Roufs)

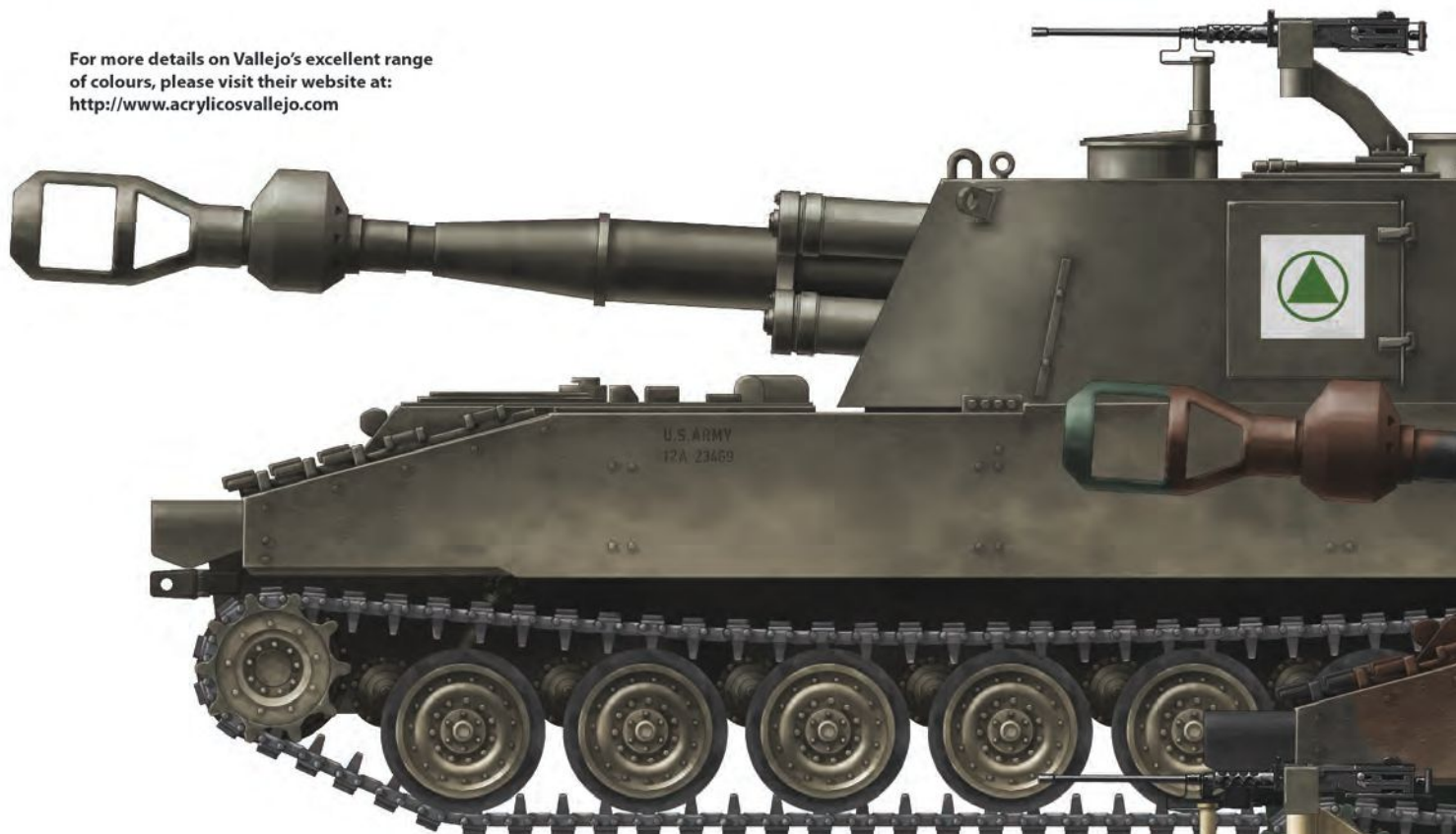
**7** An M109A6 fires during the 34th Infantry Division's 1-125 Field Artillery live fire exercise in northern Kuwait in February 2012. (U.S. Army/Sgt. Bob Brown)

**8** A loader from Battery B 1-41 Field Artillery Regiment, 1st Armored Brigade Combat Team, 3rd Infantry Division, loads a 155mm artillery round in an M109A6 during Exercise Anakonda 16 in the Drawsko Pomorskie Training Area (DPTA) near Oleszno, Poland. (U.S. Army/Sgt. Ashley Marble)

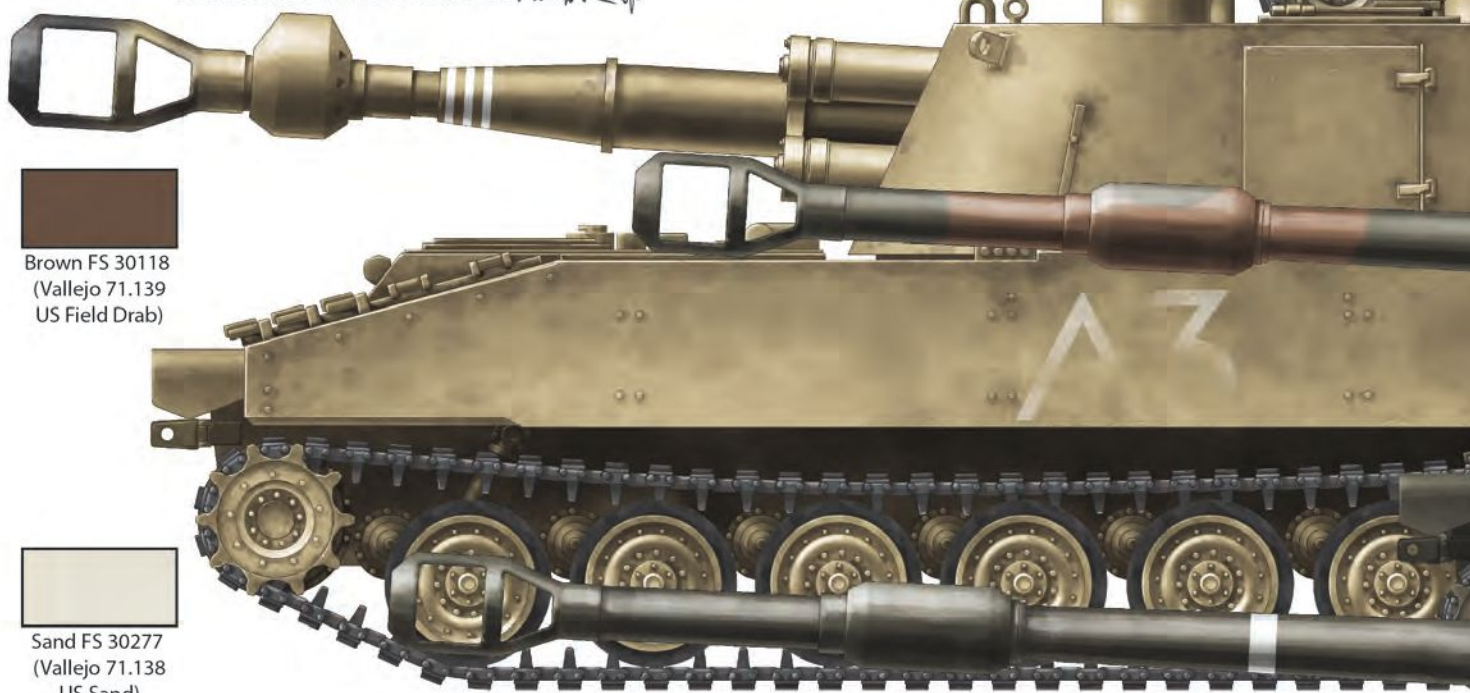
**9** A gunnery sergeant assigned to Bravo Battery, 1-201 Field Artillery Regiment, West Virginia National Guard, scans the horizon from his M109A6 for opposing forces during a battery defence exercise as part of an Exportable Combat Training Capability exercise at Camp Grayling Joint Maneuver Training Center in July 2014. (U.S. Army/Spc. Seth LaCount)



For more details on Vallejo's excellent range of colours, please visit their website at: <http://www.acrylicosvallejo.com>



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DRAWINGS & CAPTIONS BY Mark Rolfe



Brown FS 30118  
(Vallejo 71.139  
US Field Drab)

Sand FS 30277  
(Vallejo 71.138  
US Sand)

1. M109, 12A23469, attached to the 2nd Battalion, 22nd Field Artillery Regiment, 1st Armoured Division, during Exercise Reforger III Certain Forge, Germany 1971. Finish is in overall Olive Drab (Vallejo 71.043 Olive Drab). Reforger markings are in White and Green, with the vehicle serials in Black.
2. M109G, '3B', attached to 3/Panzer Artillerie Battalion 135 (PzArtBtl 135), Bundeswehr, Spilburg Barracks, circa 1980's. Finish is in Bronzegrün RAL 6031 (Vallejo 71.250 Bronze Green), Lederbraun RAL 8027 (Vallejo 71.249 NATO Brown) and Teerschwarz RAL 9021 (Vallejo 71.251 NATO Black).
3. M109, '3', operated by the 3rd Company, 3rd Battalion, Israel Defence Forces, Yom Kippur War, Sinai, 1973. Finish is in overall Sand (Vallejo 71.141 Sand Grey 73). Other markings are in White.
4. M109A1, 12A40266/'03', operated by the 3rd Armoured Division, US Army during Exercise Reforger 83. The vehicle carries the Mobility Equipment Research and Development Center (MERDC) Winter (US & Europe) Verdant scheme consisting of Green FS 34079 (Vallejo 71.294 US Forest Green), Brown FS 30118 (Vallejo 71.139 US Field Drab), Sand FS 30277 (Vallejo 71.138 US Sand) and Black FS 37038 (Vallejo 71.057 Black). The divisional marking is in Yellow and Black.
5. M109A1, '21', attached to Grupo de Artilleria de Campaña 11, Ejército de Tierra (Spanish Army), mid-1980's. Finish is in overall Olive Drab (Vallejo 71.043 Olive Drab). Markings are in White. The divisional badge of GACA 11 is carried on the front left side of the turret.







Olive Drab  
(Vallejo 71.043  
Olive Drab)



Bronzegrün RAL 6031  
(Vallejo 71.250  
Bronze Green)



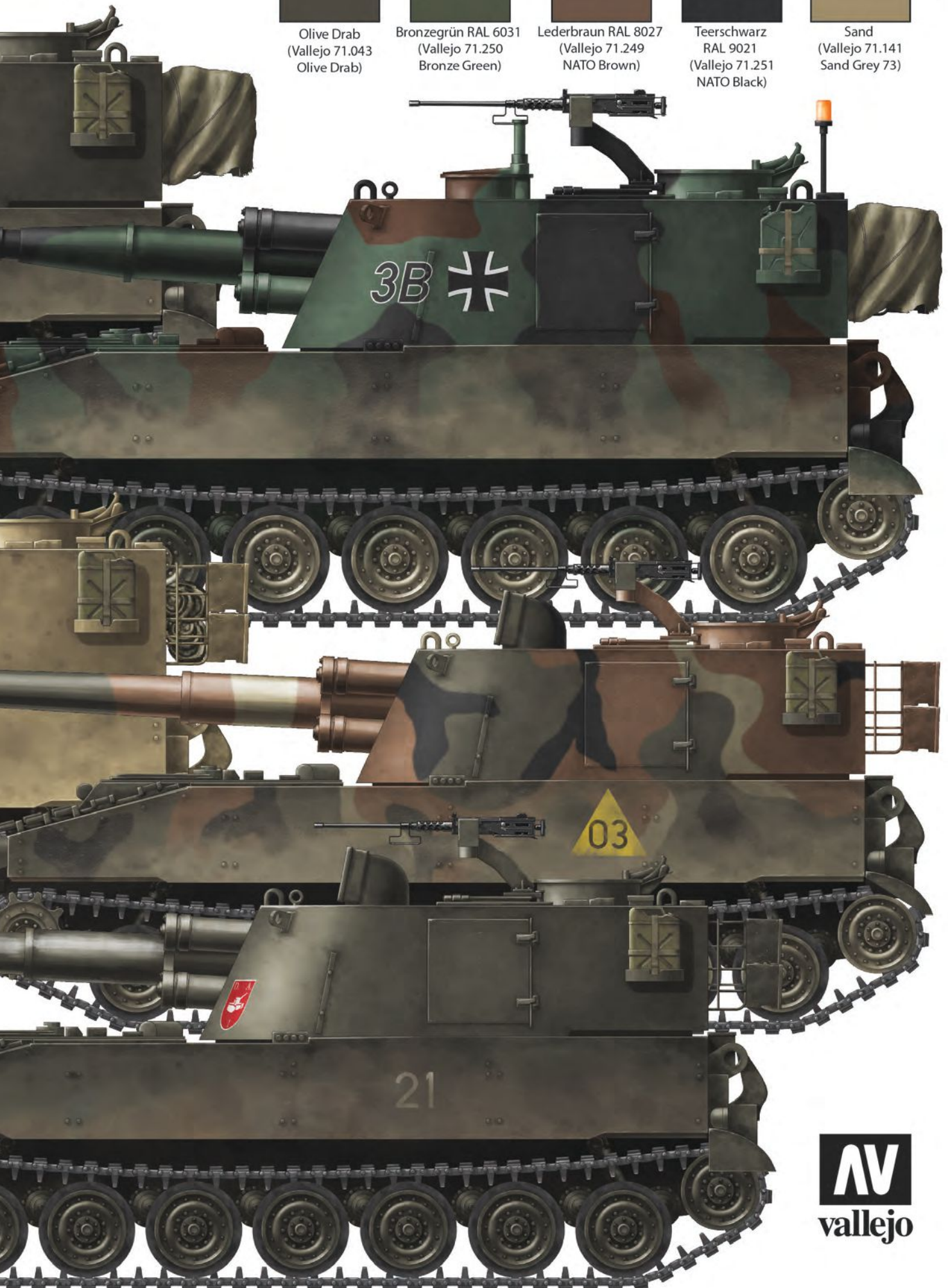
Lederbraun RAL 8027  
(Vallejo 71.249  
NATO Brown)



Teerschwarz  
RAL 9021  
(Vallejo 71.251  
NATO Black)



Sand  
(Vallejo 71.141  
Sand Grey 73)







**10** M109A6 from Battery A of the same unit establish firing positions at Grafenwoehr Training Area, Germany as they prepare to shoot their Artillery Table XII qualification. The training certified platoons as they prepared for Exercise Flaming Thunder in Lithuania and Combined Resolve VII in Germany in the late summer of 2016. (U.S. Army/Maj. Randy Ready)

**11** Airmen from the 74th Fighter Squadron and the 23rd Maintenance Group speak with soldiers from Alpha Battery, 2-29 Field Artillery, 1st Armored Division, about the mission and capabilities of the M109A6 howitzer during Exercise Iron Strike in December 2014, at the Oro Grande Range Complex, Fort Bliss, Texas. Exercise Iron Strike integrated

armoured and artillery units and A-10 aircraft for realistic joint fire and close air support execution. (U.S. Air Force/Airman 1st Class Ryan Callaghan)

**12** The unit's M109A6s during Flaming Thunder at Pabrade, Lithuania in August 2016. Flaming Thunder was a two-week long multinational fire coordination exercise and combined arms live fire to enhance interoperability among NATO fire support units, and to train and conduct joint fire support with the integration of maneuver elements, close air support and close combat attack. (U.S. Army/Sgt. James Duktavich)

**13** M109A6s from 3-29 Field Artillery Regiment, 3rd ABCT, 4th Infantry Division, drive off of a flatcar on north-eastern Poland in January 2017. The howitzer was one

of 53 vehicles that arrived in north-eastern Poland from the Port of Bremerhaven, Germany as part of Operation Atlantic Resolve. (U.S. Army/Sgt. Corinna Baltos)

**14** An M10916 of Company A, 4-1 Field Artillery Regiment after a fire mission at Al Asad Air Base, Iraq, in January 2017. Field artillery at Al Asad Air Base provided support for Iraqi security forces as part of Combined Joint Task Force – Operation Inherent Resolve, the Coalition to defeat ISIS in Iraq and Syria. (U.S. Army/Sgt. Lisa Soy)

**15** 3-29 Field Artillery Regiment then moved to conduct Table VI qualifications, firing the first 155 mm rounds in Poland at the training site in Drawsko Pomorskie. (U.S. Army/Staff Sgt. Elizabeth Tarr)

technologies of the digital battlefield. It is heavier and faster than the M109A6 but can sustain a one round per minute rate of fire with deadly accuracy. The first vehicles were delivered in April 2015 and full production of 48 vehicles in the initial batch started this year.

#### The M109 in Action

The US Army's M109s have seen action in Vietnam, in the First Gulf War, in the former Yugoslavia, and, most recently, in Iraq. After its first taste of combat in Vietnam, the M109 has proved itself a highly effective weapons system. During the First Gulf War no fewer than 582 M109A2/A3s were deployed in 25 artillery battalions, firing some 43,000 rounds. These were mainly DPICM rounds, which unleashed a rain of sub-munitions and steel fragments on the hapless Iraqi forces, but also included 100 Copperhead laser-guided munitions used to destroy enemy tanks.

In Operation Iraqi Freedom and in subsequent operations in that country the M109A6 cemented its reputation. The deployment of M109s for the 2003 invasion of Iraq was less than half of that to the Gulf twelve years earlier and as the United States fought the 'War on Terror' the continued relevance of field artillery was called into question. Indeed, the proposed successor to the M109, the Crusader project, had been cancelled in May 2002 and the artillery was conspicuous by its absence from the operations in Afghanistan. During Operation Iraqi Freedom the Iraqi artillery both outranged and outnumbered the divisional artillery deployed with 101st Airborne and 3rd Infantry Division, yet time and time again it proved itself essential in destroying enemy artillery and rocket systems. During sandstorms, the M109s and other guns provided artillery cover in the absence of air support. Essentially, during the invasion of Iraq the M109A6 excelled in the traditional role of artillery: providing effective and integrated close fire support to the infantry. The impact of the M109A6 was further enhanced by the presence of the M7 Bradley Fire Support Team





Vehicle, which could keep up with the forward elements of the Combined Arms infantry and armour combat teams, providing precise coordinates within 50 metres at ranges up to 8,000 metres. The ability of the Paladin to keep up with the Bradleys and the Abrams, indeed the insistence of field commanders that they did so, and to provide both direct and indirect accurate fire support quickly was key to the remarkable success it enjoyed in the opening encounters of Operation Iraqi Freedom. The Paladin's success in suppressing the Iraqi artillery meant that during the invasion no American lives were lost to enemy artillery fire. A brigade commander from 3rd Infantry Division noted *"the Iraqis had a lot of artillery, he used it extensively, but the combination of Paladin howitzers and the [Hughes AN/TP]Q36 [weapon locating] radar was deadly. If he didn't move, he was dead. The 1-10 Field Artillery fired about 1,000 rounds during the battles around An Nasiriyah. The Iraqis [as a result] very seldom massed fires."* ('U.S. Army Field Artillery Relevance on the Modern Battlefield', Marine Corps University, 2004)

### Conclusion

Operation Iraqi Freedom and the subsequent actions by the US armed forces in that country confirmed the importance of the M109 to combined arms manoeuvre warfare. Alongside the M1 Abrams MBT and the Bradley Fighting Vehicle, the M109 is central to American war-fighting doctrine as the US Army reorients itself towards peer-to-peer or near-peer encounters. Put simply, the Paladin will be around for a few decades to come.





**16** An M992A2 Field Artillery Ammunition Supply Vehicle from 1-5 Field Artillery Regiment, 1st ABCT, 1st Infantry Division, resupplies an M109A6 Paladin artillery system with ammunition during a gunnery qualification training event in Yeoncheon-gun, South Korea in March 2017. (U.S. Army/Capt. Jonathan Camire)

**17** The crew of a Mississippi National Guard M109A6 from the 155th Armored Brigade Combat Team, observes a passing helicopter at the National Training Center in June 2017. (Mississippi National Guard/Sgt. Edward Lee)

**18** Soldiers of 3-29 Field Artillery Regiment prepare to fire an M109A6 during Exercise *Combined Resolve VIII* at the Grafenwoehr Training Area, Germany in April 2017. *Combined Resolve* happens twice yearly and is the U.S. Army Europe Command's most important field training exercise, involving thousands of servicemen and women from the U.S. and other NATO and partner nations. (U.S. Army/photo by Spc. Randy Wren)

**19** Soldiers of 3-29 Field Artillery Regiment, 3rd ABCT, 4th Infantry Division, ground guide their M109A6s to the firing point during a direct fire exercise at the 7th Army Training Command's Grafenwoehr Training Area, Germany, in September 2017. (U.S. Army/Staff Sgt. Ange Desinor)

**20** An M109A6 fires during a live fire exercise for 3-16 Field Artillery Regiment, 210th Field Artillery Brigade, 2nd Infantry Division/ROK-US Combined Division at a live fire training area in Yeoncheon-gun, South Korea, in September 2017. (U.S. Army/Pfc. Hyeonmin Lee)

**21** An M109A6 Paladin assigned to 4-1 Field Artillery Regiment at Fort Bliss, Texas in December 2017. This was part of an area occupation exercise, within 1st Armored Division Artillery's *Best by Test* competition. (U.S. Army/Sgt. Kris Bonet)

**22** M109A6s of the same unit in preparation for a live fire exercise at Grafenwoehr Training Area, in February 2018. Note the camouflage netting on the side of the vehicle, characteristic of AFVs of 2nd ABCT. (U.S. Army/Markus Rauchenberger)

**23** Battery A, 1-7 Field Artillery Regiment, 2nd ABCT, 1st Infantry Division, prepare their M109A6s during a live fire exercise at Grafenwoehr Training Area, in January 2018. (U.S. Army/Markus Rauchenberger)

**24** Another 1-7 Field Artillery Regiment M109A6 at Grafenwoehr. Note the locally applied coat of washable Bronze Green paint, applied over the standard CARCTan finish. (U.S. Army/Staff Sgt. Sharon Matthias)

**25** A useful overhead view of a pristine M109A6 of 11th Armored Cavalry Regiment during the annual Armed Forces Day Parade held in May each year in the Californian town of Torrance. (U.S. Army/Sgt. Justin May)

**26** The M109A7, the future of US self-propelled artillery. (BAE Systems)









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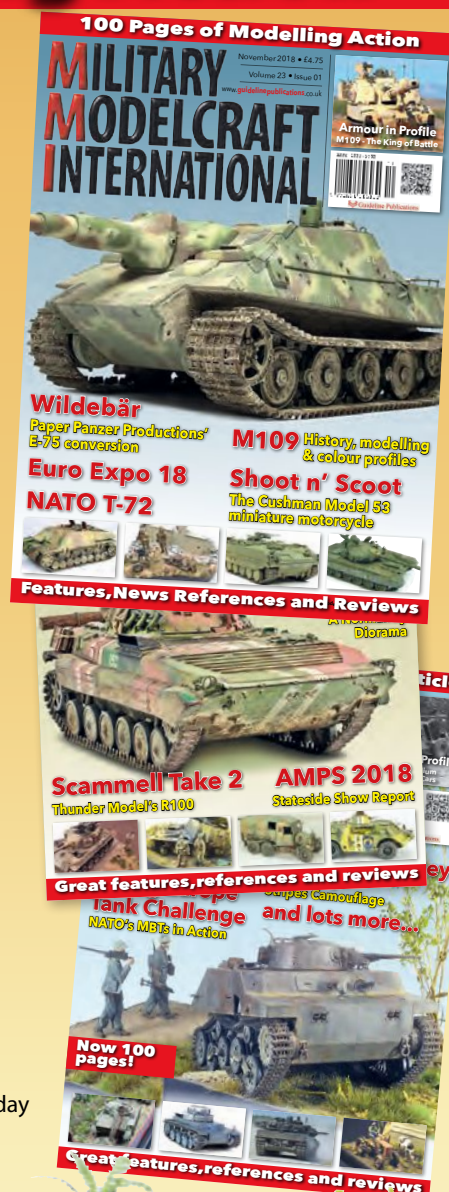
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## Great features, references and reviews



# ARMOUR IN PROFILE

An M1A2 SEP V2 of 2nd Armoured Brigade Combat Team, 1st Infantry Division, crosses the Hohenfels Training Ground, Germany, as part of Exercise Combined Resolve X in May 2018. (U.S. Army/1st Sgt. Rebecca Edwards-Trader)





# ARMOUR IN PROFILE

**A**rmour in Profile: Armoured Fighting Vehicles of the United States Army, 1945-2018 contains profiles of five armoured fighting vehicles that have shaped the strategy and tactics of the United States Army since the end of World War II. From the battlefields of the Korean Peninsula and the jungles of Vietnam, to the plains of Central Europe and deserts of Iraq and Kuwait, these vehicles are iconic of American military might. Beginning with the M47 and M48 Patton tanks, replacements for the M4 Sherman, it goes on to examine the M60 tank and the mighty M1 Abrams Main Battle Tank, a vehicle that is expected to serve as the principal weapon of the U.S. Army for at least another two decades. As well as these main battle tanks, it profiles the 'King of Battle', the M109 self-propelled howitzer, another relic of the Cold War continuously updated to meet the challenges of warfare in the twenty-first century. Finally, the book looks at the 'REFORGER' exercises held in the 1970s and 80s, at the height of the Cold War, and which moved thousands of U.S. personnel and vehicles to Germany on an annual basis.

**1** Two M60A3 tanks during Exercise Central Guardian in Germany 1985. (U.S. Army/Tech. Sgt. Boyd Belcher)

**2** An M1A1 Abrams of 1st Armored Division. (U.S. Army/Eric Steen)

**3** An M109A6 of 1st Cavalry Division in Torun, Poland, 2018. (U.S. Army/Sgt. Christopher Case)

**Front cover:** An M1A2 Abrams takes part in the Strong Europe Tank Challenge in 2017 against tanks from five other NATO and partner nations. (U.S. Army/Spc. Nathanael Mercado)



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